NATURAL HISTORY,

GENERAL AND PARTICULAR,

BY THE

COUNT DE BUFFON,

TRANSLATED INTO ENGLISH.

ILLUSTRATED

WITH ABOVE 300 COPPER-PLATES,

AND OCCASIONAL

NOTES AND OBSERVATIONS.

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SECOND EDITION.

VOL. II.

LONDON:
Printed for W. STRAHAN and T. CADELL, in the Strand.

M,DCC,LXXXV.

19531
10/12/91
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GENERAL

GENERAL HISTORY

OF

ANIMALS.

CHAPTER I.

Analogies between Animals and Vegetables.

AMONG the numberleſs objects with which the ſurface of this globe is covered and peopled, animals hold the firſt rank, both on account of the relation they bear to man, and of their acknowledged ſuperiority over vegetable and inanimated matter. The ſenſes, the figure, and the motions of animals, beſtow on them a more extenſive connection with ſurrounding objects than is poſſeſſed by vegetables. The latter, however, from their expanſion, their growth, and the variety of parts of which they are compoſed, are more intimately related to external objects than minerals or ſtones, which are perfectly inert, and deprived of every vital or active principle. It is this number of relations alone which render the animal ſuperior to the vegetable, and the vegetable to the mineral. Man, if we eſtimate him by his material part alone, is ſuperior to the brute creation only from the number of peculiar relations he enjoys by means of his hand and of his tongue; and, though all the operations of the Omnipotent are in themſelves equally perfect, the animated being, according to our mode of perception, is the moſt complete; and man is the moſt finiſhed and perfect animal.

What a variety of ſprings, of powers, and of mechanical movements, are included in that ſmall portion of matter of which the body of an animal is compoſed! What a number of relations, what harmony, what correſpondence among the different parts! How many combinations, arrangements, cauſes, effects, and principles, all conſpiring to accompliſh the ſame deſign! Of theſe we know nothing but by their reſults, which are ſo difficult to comprehend, that they ceaſe only to be miraculous from our habits of inattention and our want of reflection.

But, however admirable this work may appear, the greateſt miracle is not exhibited in the individual. It is in the ſucceſſive renovation, and in the continued duration of the ſpecies, that Nature aſſumes an aſpect altogether inconceivable and aſtoniſhing. This faculty of reproduction,

duction *, which is peculiar to animals and vegetables; this species of unity which always subsists, and seems to be eternal; this generative power, which is perpetually in action, must, with regard to us, continue to be a mystery so profound, that we shall probably never reach its bottom.

Even inanimated bodies, the stones or the dust under our feet, have some properties; their very existence presupposes a great number; and matter, the most imperfectly organized, possesses many relations with the other parts of the universe. We will not assert, as some philosophers have done, that matter, under whatever form it appears, is conscious of its existence and of its relative powers. This question belongs to metaphysics, of which we intend not to treat. We shall only remark, that, being ignorant of the extent of our own connections with external objects, we cannot hesitate in pronouncing inanimated matter to be infinitely more ignorant. Besides, as our sensations have not the most distant resemblance to the causes which produce them, analogy obliges us to conclude, that dead matter is neither endowed with sentiment, with sensation, nor with a consciousness of its own existence. Hence, to attribute any of

 these

* This word is frequently used by the author, and requires to be explained. It signifies the power of producing or propagating in general, and is equally applicable to plants and to animals. Generation is a species of reproduction peculiar to animated beings.

theſe faculties to matter, would be aſcribing to it the power of thinking, of acting, and of perceiving, nearly in the ſame maner as we ourſelves think, act, and perceive; which is equally repugnant to reaſon and religion.

With inanimated matter, therefore, though formed of duſt and clay, we have no other relations than what ariſe from the general properties of bodies, ſuch as, extenſion, impenetrability, gravity, &c. But, as relations purely material make no internal impreſſion on us, and, as they exiſt entirely independent of us, they cannot be conſidered as any part of our being. Our exiſtence, therefore, is an effect of organization, of life, of the ſoul. Matter, in this view, is not a principal, but an acceſſory. It is a foreign covering, united to us in a manner unknown; and its preſence is noxious. Thought is the conſtituent principle of our being, and is perhaps totally independent of matter.

We exiſt, then, without knowing how; and we think, without perceiving the reaſon of thought. But, whatever be the mode of our being, or of our thinking, whether our ſenſations be real or apparent, their effects are not the leſs certain. The train of our ideas, though different from the objects which occaſion them, gives riſe to genuine affections, and produces in us relations to external objects, which we may regard as real, becauſe they are uniform and invariable. Thus, agreeable to the nature of our being,

being, it is impoſſible to doubt concerning the reality of thoſe diſtinctions and reſemblances which we perceive in the bodies that ſurround us. We may, therefore, conclude, without heſitation, that man holds the firſt rank in the order of nature; and that brute animals hold the ſecond, vegetables the third, and minerals the laſt. Though we are unable clearly to diſtinguiſh between our animal and ſpiritual qualities; though brutes are endowed with the ſame ſenſes, the ſame principles of life and motion, and perform many actions in a manner ſimilar to thoſe of man; yet they have not the ſame extent of relation to external objects; and, conſequently, their reſemblance to us fails in numberleſs particulars. We differ ſtill more from vegetables; but we are more analogous to them than to minerals; for vegetables poſſeſs a ſpecies of animated organization; but minerals have nothing that approaches to regular organs.

Before we give the hiſtory of an animal, it is neceſſary to have an exact knowledge of the general order of his peculiar relations, and then to diſtinguiſh thoſe relations which he enjoys equally with vegetables and minerals. An animal poſſeſſes nothing common to the mineral but the general properties of matter: His nature and oeconomy, however, are perfectly different. The mineral is inactive, inſenſible, ſubject to every impulſe, without organization, or the power of reproduction, a rude maſs, fitted only to be trode by the feet of men and of animals.

Even the moſt precious metals, which derive their value from the conventions of men only, are regarded in no other light by the philoſopher. In the animal, the whole powers of nature are united. The principles with which he is animated are peculiar to him: He wills; he determines; he acts; he communicates, by his ſenſes, with the moſt diſtant objects; his body is a world in miniature, a central point to which every thing in the univerſe is connected. Theſe are his peculiar and invariable relations: The faculties of growth and expanſion, of reproduction and the multiplication of his ſpecies, he poſſeſſes in common with the vegetable kingdom.

Progreſſive motion appears to be the moſt diſtinguiſhing quality between an animal and a vegetable. We, indeed, know no vegetable that enjoys a loco-motive faculty. But this motion is denied to ſeveral ſpecies of animals, as oyſters*, gall-inſects, &c. This diſtinction, therefore, is neither general nor eſſential.

Senſation more eſſentially diſtinguiſhes animals from vegetables. But *ſenſation* is a complex idea, and requires ſome explication; for, if ſenſation implied no more than motion conſequent upon a ſtroke or impulſe, the ſenſitive plant enjoys this power. But, if by ſenſation we mean the faculty of perceiving and of comparing ideas, it is uncertain whether brute animals

* This is not ſtrictly true; for oyſters, and even gall-inſects, are capable of a degree of local motion.

mals are endowed with this faculty. If it ſhould be allowed to dogs, elephants, &c. whoſe actions ſeem to proceed from motives ſimilar to thoſe by which men are actuated, it muſt be denied to many ſpecies of animals, particularly to thoſe that appear not to poſſeſs the faculty of progreſſive motion. If the ſenſation of an oyſter, for example, differ in degree only from that of a dog, why do we not aſcribe the ſame ſenſation to vegetables, though in a degree ſtill inferior? This diſtinction, therefore, between the animal and vegetable, is neither ſufficiently general nor decided.

A third diſtinction has been derived from the manner of feeding. Animals have organs of apprehenſion by which they lay hold of their food; they ſearch for paſture, and have a choice in their aliment. But plants are under the neceſſity of receiving ſuch nouriſhment as the ſoil affords them, without exerting any choice in the ſpecies of their food, or in the manner of acquiring it: The moiſture of the earth is the only ſource of their nouriſhment. However, if we attend to the organization and action of the roots and leaves, we ſhall ſoon be convinced, that theſe are the external organs by which vegetables are enabled to extract their food; that the roots turn aſide from a vein of bad earth, or from any obſtacle which they meet with, in ſearch of a better ſoil; and that they ſplit and ſeparate their fibres in different directions, and

even

even change their form, in order to procure nourishment to the plant. A general distinction, therefore, between the animal and vegetable, cannot be founded on their manner of feeding.

From this investigation we are led to conclude, that there is no absolute and essential distinction between the animal and vegetable kingdoms; but that nature proceeds by imperceptible degrees from the most perfect to the most imperfect animal, and from that to the vegetable: Hence the fresh water polypus may be regarded as the last of animals, and the first of plants.

After examining the distinctions, we shall now inquire into the resemblances which take place between animals and vegetables. The power of reproduction is common to the two kingdoms, and is an analogy both universal and essential. This mutual faculty would induce us to think that animals and vegetables are beings of the same order.

A second resemblance may be derived from the expansion of their parts, which is likewise a common property; for vegetables grow as well as animals; and, though some difference in the manner of expansion may be remarked, it is neither general nor essential; since the growth of some considerable parts of animals, as the bones, the hairs, the nails, the horns, &c. is the effect of a genuine vegetation; and the foetus, in its first formation, may be rather said to vegetate than to live.

A third reſemblance ariſes from the following fact: Some animals are propagated in the ſame manner and by the ſame means, as vegetables. The multiplication of the vine-fretter, (*puceron*), which is effected without copulation, is ſimilar to that of plants by ſeed; and the multiplication of the polypus by cuttings reſembles that of plants by ſlips.

We may, therefore, conclude, with more certainty, that animals and vegetables are beings of the ſame order, and that Nature paſſes from the one to the other by imperceptible degrees; ſince the properties in which they reſemble each other are univerſal and eſſential, while thoſe by which they are diſtinguiſhed are limited and partial.

Let us next compare animals and vegetables in different points of view; for example, with regard to number, ſituation, magnitude, figure, &c. from which new inductions will ariſe.

Animals exceed plants in the number of ſpecies. In the claſs of inſects alone, there are, perhaps, a greater number of ſpecies, than of the whole ſpecies of plants on the face of the earth. Animals differ from each other much more than plants: It is the great ſimilarity of plants that has given riſe to the difficulty of diſtinguiſhing and arranging them, and to the variety of botanical ſyſtems, which are much more numerous than thoſe of zoology.

Beſide

Beſide being more ſtrongly characteriſed, every ſpecies of animal is diſtinguiſhable from another by copulation. Thoſe may be regarded as of the ſame ſpecies which, by copulation, uniformly produce and perpetuate beings every way ſimilar to their parents; and thoſe which, by the ſame means, either produce nothing, or diſſimilar beings, may be conſidered as of different ſpecies. A fox, for example, will be of a different ſpecies from a dog, if nothing reſults from the intercourſe of a male and a female of theſe two animals; or, if the reſult be a diſſimilar creature, a kind of mule, as this mule cannot multiply, it will be a ſufficient demonſtration that the fox and dog are different ſpecies of animals. In plants, we have not the ſame advantage; for, though ſexes have been attributed to them, and generic diſtinctions have been founded on the parts of fructification; yet, as theſe characteriſtics are neither ſo certain nor ſo apparent as in animals; and, as the reproduction of plants can be accompliſhed by ſeveral methods which have no dependence on ſexes, or the parts of fructification, this opinion has not been univerſally received; and it is only by the miſapplication of analogy, that the ſexual ſyſtem has been pretended to be ſufficient to enable us to diſtinguiſh the different ſpecies of the vegetable kingdom.

Though the ſpecies of animals be more numerous than thoſe of plants, the number of individuals

viduals in each ſpecies of the latter far exceed thoſe of the former. In animals, as well as in plants, the number of individuals is much greater in the ſmall than in the large kinds. Flies are infinitely more numerous than elephants; and there are more herbs than trees. But, if we compare the number of individuals in each ſpecies, the individuals in each ſpecies of plant far exceed thoſe of the animal. Quadrupeds, for example, produce but few at a time, and at conſiderable intervals. Trees, on the contrary, produce annually an amazing number of ſeeds. It may be alledged, that, to render this compariſon exact, the number of ſeeds produced by a tree ſhould be compared with the number of germs contained in the ſemen of an animal; and then, perhaps, it would appear, that animals abound more in germs than vegetables. But, by collecting and ſowing the ſeeds of a ſingle elm tree, 100,000 young elms may be raiſed from the product of one year. Though a horſe, however, were furniſhed with all the mares he could cover in a year, the reſult between the production of the animal and of the plant would be very different. I avoid taking notice of the number of germs; becauſe of theſe, eſpecially in the animal, we have no certain knowledge, and becauſe the ſame ſeminal germs may exiſt in the vegetable; for the ſeed of a plant is not a germ, but a production as perfect as the foetus of an animal, and which,

which, like a foetus, requires only the expanſion of its parts.

To this may be oppoſed the prodigious multiplication of ſome kinds of inſects, as the bee, a ſingle female of which will produce 30 or 40 thouſand. But, it ought to be remarked, that I am here ſpeaking in general of animals compared with vegetables. Beſides, the bee, which affords, perhaps, an example of the greateſt multiplication among animals, proves nothing againſt the preſent doctrine; for, out of 30 or 40 thouſand flies produced by the mother-bee, there are but very few females, and no leſs than 1500 or 2000 males: The reſt are of neither ſex, and totally incapable of procreating.

It muſt be acknowledged, that ſome ſpecies of inſects, fiſhes, and ſhell-animals, appear to be extremely prolific. Oyſters, herrings, fleas, &c. are perhaps equally fertile as moſſes, and the moſt common plants. But, in general, moſt ſpecies of animals are leſs prolific than plants; and, upon comparing the multiplication of the different ſpecies of plants, we find not ſuch remarkable differences, with regard to number, as take place among animals. Some animals produce great numbers, and others very few. But, in every ſpecies of plants, the quantity produced is always great.

From what we have already obſerved, it appears, that, both in the animal and vegetable kingdoms, the ſmalleſt and moſt contemptible ſpecies

ſpecies are the moſt prolific. In proportion as animals ſeem to be more perfect, the number of individuals decreaſes. Does the production of particular forms of body, neceſſary for the perfecting of ſentiment, as thoſe of quadrupeds, and of birds, coſt nature more expence of organic particles than the production of inferior creatures?

Let us now compare animals and vegetables with regard to ſituation, ſize, and figure. Vegetables can exiſt no where but on the earth. Moſt of them are attached to the ſoil by roots: Some, as truffles, are entirely covered with the ſoil; and a few grow under water. But the whole require a connection with the ſurface of the earth. Animals, on the contrary, are more generally diffuſed. Some inhabit the ſurface, and others the interior parts of the earth. Some never riſe above the bottom of the ocean, and others ſwim in the waters. The air, the internal parts of plants, the bodies of men and of other animals, and even ſtones themſelves, are ſtored with inhabitants.

By the aſſiſtance of the microſcope, many new ſpecies of animals have been diſcovered. But, what is ſingular, we are not indebted to this inſtrument for above one or two ſpecies of plants. The ſmall moſs, of which mouldineſs conſiſts, is perhaps the only microſcopic plant that has been deſcribed. From this it would appear, that Nature has refuſed exiſtence to very ſmall plants, while

while ſhe has created animalcules in the greateſt profuſion. But this opinion ſhould not be adopted without examination. Plants are ſo ſimilar in their ſtructure, that it is much more difficult to diſtinguiſh them than animals. This mouldineſs, which we imagine to be only a very ſmall moſs, may be a foreſt or a garden conſiſting of a multitude of different plants, though we are unable to diſtinguiſh them.

Animals and vegetables differ alſo with regard to ſize. There is a greater diſproportion between the bulk of a whale and that of one of theſe pretended microſcopic animals, than between the largeſt oak and the ſmall moſs mentioned above. Though bulk be only a relative attribute, it may be uſeful to know the limits within which nature has confined her productions. As to largeneſs, plants differ but little from animals. The quantity of matter in a whale and in a large tree is nearly equal; but, as to ſmallneſs, ſome men have pretended to have ſeen animals ſo extremely minute, that a million of them collected in a heap would not equal the ſmall moſs on a piece of mouldy bread.

The moſt general and moſt obvious diſtinction between plants and animals ariſes from their figure. The form of animals, though infinitely various, has no reſemblance to that of plants: And, though the polypi, which, like plants, can be multiplied by cuttings, may be regarded as the link which connects the animal and vegetable

table kingdoms, not only from the manner of their reproduction, but ſtill more from their figure; yet there is no danger of miſtaking the one for the other. The operations of ſome animals reſemble plants or flowers. But plants never produce any thing ſimilar to an animal; and thoſe wonderful inſects which make corals, would never have been miſtaken for flowers, if, by a fooliſh prejudice, coral had not been regarded as a plant. Thus the errors we may commit in comparing plants and animals, are confined to a few objects which lie on the extremities of the two kingdoms; and the farther we extend our obſervations, we ſhall be the more convinced, that the Creator has inſtituted no fixed limits between the animal and vegetable; that theſe two ſpecies of organized beings poſſeſs a greater number of common properties than of real differences; that the production of an animal requires, perhaps, a ſmaller exertion of Nature than the production of a vegetable; or rather, that the production of organized bodies requires no immediate exertion at all; and, laſtly, that animation, or the principle of life, inſtead of a metaphyſical ſtep in the ſcale of being, is a phyſical property common to all matter.

CHAPTER II.

Of Reproduction in general.

WE ſhall now examine more cloſely this property, which is common to the animal and vegetable, this faculty of producing beings ſimilar to themſelves, this ſucceſſive chain of individuals which conſtitutes the real exiſtence of the ſpecies: And, without limiting our reſearch to the generation of man, or of any particular animal, let us contemplate the general phaenomena of reproduction; let us collect facts, and enumerate the various methods employed by Nature for the renovation and tranſmiſſion of organized exiſtences.

The firſt, and apparently the moſt ſimple method, is to aſſemble in one body an infinite number of ſimilar organic bodies, and to compoſe its ſubſtance in ſuch a manner, that every part ſhall contain a germ or embryo of the ſame ſpecies, and which might become a whole of the ſame kind with that of which it conſtitutes a part *.

This

* The intelligent reader will perceive that this ſentence, though not very obvious, contains the principle upon which the ſubſequent theory of generation adopted by the author is founded. It means no more than that the bodies of animals and of vegetables are compoſed of an infinite number of organic particles, perfectly ſimilar, both in figure and ſubſtance, to the whole animal or plant, of which they are the conſtituent parts.

This apparatus appears, at firſt ſight, to ſuppoſe a profuſion of expence. Such magnificence, however, is not uncommon in Nature. It is diſcernible even in the more common and inferior ſpecies, as in worms, polypi, elms, willows, and many other plants and inſects, every part of which contains a whole, and, in order to become a plant or an inſect, requires only to be unfolded or expanded. Conſidering organized bodies under this point of view, an individual is a whole uniformly conſtructed in all parts, a collection of an infinite number of particles every way ſimilar, an aſſemblage of germs or minute individuals of the ſame ſpecies, which, in certain circumſtances, are capable of being expanded, and of becoming new beings like thoſe from which they were originally ſeparated.

This idea, when traced to the bottom, diſcovers a relation between animals, vegetables, and minerals, which we would not have ſuſpected. Salts, and ſome other minerals, conſiſt of parts ſimilar to one another, and to the whole. A grain of ſea-ſalt, as we diſtinctly perceive by the microſcope, is a cube compoſed of an infinite number of ſmaller cubes *, which, as we diſco-

* Hae tam parvae quam magnae figurae (ſalium) ex magno ſolum numero minorum particularum, quae eandem figuram habent, ſunt conflatae, ſicuti mihi ſaepe licuit obſervare, cum aquam marinam aut communem in qua ſal commune liquatum erat, intueor per microſcopium, quod ex ea prodeunt elegantes, parvae, ac quadrangulares figurae adeo exiguae, ut mille earum myriades

ver by a larger magnifier, are themſelves compoſed of ſtill ſmaller cubes. The primitive and conſtituent particles of this ſalt muſt, therefore, unqueſtionably conſiſt of cubes ſo minute, that they will for ever eſcape our obſervation. Plants and animals, which poſſeſs the power of multiplying by all their parts, are organized bodies compoſed of ſimilar organic bodies, the primitive and conſtituent particles of which are alſo organic and ſimilar. Of theſe we diſcern the accumulated quantity ; but we can only recogniſe the conſtituent particles by reaſon and analogy.

From this view, we are led to conclude, that there exiſts in nature an infinity of *organic, living particles* *, of the ſame ſubſtance with organized beings. A ſimilar ſtructure we have already remarked in more inanimated matter, which is compoſed of an infinite number of minute particles that have an exact reſemblance to the whole body. And, as the accumulation perhaps of millions of cubes are neceſſary to the formation

myriades magnitudinem arenae craſſioris ne aequent. Quae ſalis minutae particulae, quam primum oculis conſpicio, magnitudine ab omnibus lateribus creſcunt, ſuam tamen elegantem ſuperficiem quadrangularem retinentes, fere . . . . . Figurae hae ſalinae cavitate donatae ſunt, &c. ; *See Leeuwenhoek, Arc. Nat. tom.* I. *p.* 3.

* To avoid the introduction of terms which might not be generally underſtood, it is neceſſary to inform the reader, that the phraſes *corps organiques vivans, parties organiques vivantes*, et *molecules organiques vivantes*, which occur ſo often in this volume, and form the baſis of our author's theory, are uniformly, in the verſion, expreſſed by the words *organic particles*.

formation of a ſingle grain of ſea-ſalt that is perceptible by our ſenſes, an equal number of ſimilar organic particles are requiſite to produce one of thoſe numberleſs germs contained in an elm, or in a polypus. A cube of ſea-ſalt muſt be diſſolved before we can diſcover, by means of cryſtallization, the minute cubes of which it is compoſed: In the ſame manner, the parts of an elm or of a polypus muſt be ſeparated, before we can recogniſe, by means of vegetation, or expanſion, the ſmall elms or polypi contained in the different parts of theſe bodies.

The difficulty of aſſenting to this idea proceeds from the well known prejudice, that we can only judge of the compound by the ſimple; that, to diſcover the organic ſtructure of any being, it muſt firſt be reduced to its ſimple and unorganic parts; and that hence it is more eaſy to conceive how a cube muſt neceſſarily be compoſed of other cubes, than how a polypus can be compoſed of other polypi. But, if we examine attentively what is meant by ſimple and compound, we ſhall find, that in this, as in every thing elſe, the plan of Nature is very different from the groſſneſs and imperfection of our conceptions.

Our ſenſes, it is well known, convey not to us exact repreſentations of external objects. When we want to calculate, to judge, to compare, to weigh, to meaſure, &c. we are obliged to have recourſe to foreign aid, to rules, to principles, to uſages, to inſtruments, &c. All theſe adminicles are efforts of human genius, and belong more or leſs to the abſtraction of our ideas. This abſtraction, with regard to us, conſtitutes the ſimplicity of things; and the difficulty of reducing them to this abſtraction is the compound. Extenſion, for example, being a general and abſtract property of matter, is not much compounded. In order, however, to judge concerning it, we have imagined ſome extenſions to have no thickneſs, others to have neither thickneſs nor breadth, and points, which are extenſions without being extended. All theſe abſtractions have been invented as ſupports to the underſtanding; and the few definitions employed in geometry have given riſe to numberleſs prejudices and falſe conceptions. Whatever is reducible under any of theſe definitions is called ſimple; and ſuch things as cannot be eaſily reduced to this ſtandard are conſidered as complex. Thus, a triangle, a ſquare, a circle, a cube, and alſo thoſe curves of which we know the geometrical properties, are regarded as ſimple. But every thing which we cannot reduce under theſe figures, or abſtract rules, appears to us to be complex. We never reflect, that all theſe geometrical figures exiſt no where but in our own imaginations, or that, if they are ever found in Nature, it is only becauſe ſhe exhibits every poſſible form; and the appearance of ſimple figures, as an exact cube, or an equilateral pyramid, is, perhaps,

perhaps, more difficult and rare to be found in Nature, than the complex forms of plants or of animals. It is in this manner that we perpetually consider the abstract as simple, and the real as complex. But, in nature, no abstract exists; nothing is simple; every object is compounded. We are unable to penetrate into the intimate structure of bodies. We cannot, therefore, determine what objects are more or less complex, unless by the greater or less relation they have to ourselves, and to to the rest of the universe. For this reason we regard the animal as being more complex than the vegetable, and the vegetable than the mineral. With respect to us, this notion is just; but we know not whether the animal, vegetable, or mineral, be, in reality, the most complex or the most simple; and we are ignorant whether the production of a globe or a cube requires a greater effort of Nature than that of a germ, or an organic particle. If we were to indulge in conjectures upon this subject, we might imagine that the most common and numerous objects are the most simple. But this would make animals more simple than plants or minerals; because the former exceed the latter in number of species.

But, without dwelling longer on this subject, it is sufficient to have shown, that all our notions concerning simple and compound are abstract ideas; that they cannot be applied to the complex operations of nature; that, when we attempt to reduce all bodies into elements of a cubical, prifmatic, globular, or any other regular figure, we fubftitute our own imaginations in oppofition to real exiftences; and that the forms of the conftituent particles of different bodies are abfolutely unknown to us; and, of courfe, we may believe or fuppofe that organized beings are compofed of fimilar organic particles, as well as that a cube confifts of other cubes. We have no other method of judging but by experience. We know that a cube of fea-falt is compofed of many leffer cubes, and that an elm confifts of a great number of minute elms; becaufe if we take a piece of a branch, of a root, of the wood feparated from the trunk, or a feed, from all thefe a new tree is produced. The polypus, and fome other fpecies of animals, may likewife be multiplied by cuttings feparated from any part of their bodies; and, as our rule of judging in both cafes is the fame, why fhould we form a different opinion concerning them?

The above reafoning renders it extremely probable, that there really exifts in Nature an infinite number of fmall organized beings, every way fimilar to thofe large organized bodies which make fuch a confpicuous figure in this world; that thefe fmall organized beings are compofed of living organic particles, which are common both to animals and vegetables, and are their primary and incorruptible elements; that an affemblage of thefe particles conftitutes an animal

animal or a plant; and, consequently, that reproduction or generation is nothing but a change of form, effected solely by the addition of similar particles; and the death, or resolution of organized bodies, is only a separation of the same particles. Of the truth of this doctrine, not a doubt will remain, after the proofs delivered in the following chapters are perused. Besides, if we reflect on the growth of trees, and consider what an immense mass is produced from so small an origin, we must be persuaded that this increase of matter is effected by the simple addition of organic particles which are similar to one another and to the whole. The seed first produces a small tree, which it contained in miniature within its coats. At the top of this small tree a bud is formed, which contains the tree that is to spring the next season; and this bud is an organized body similar to the small tree of the preceding year. The small tree of the second year, in the same manner, produces a bud which contains a tree for the third year; and this process uniformly goes on as long as the tree continues to vegetate: Buds are likewise formed at the extremity of each branch, which contain, in miniature, trees similar to that of the first year. It is evident, therefore, that trees are composed of minute organized bodies similar to themselves, and that the whole individual is formed by a numerous assemblage of minute and similar individuals.

But,

But, it may be demanded, were not all these minute, and similarly organized bodies, contained in the seed? and may not the order of their unfolding be traced from that source? for it is apparent, that the first bud was surmounted by a similar bud, which was not expanded till the second year, and the third bud was not unfolded till the third year; and, consequently, the seed may be said to have really contained the whole buds which would be formed for 100 years, or till the dissolution of the plant: It is also apparent, that this seed contained not only all the small organized bodies which must in time have constituted the individual tree itself, but likewise all the seeds, and all the individuals which would successively arise, till the final destruction of the species.

This, indeed, is a capital difficulty: We shall therefore examine it with the greater attention. It is true, that the seed produced a small tree the first year, solely by the unfolding of the bud or germ which it contained, and that this small tree existed in miniature in the bud. But it is not equally certain that the bud of the second year, and those of the succeeding years, nor that all the small organic bodies, and the seeds which must have been formed till the end of the world, or the destruction of the species, were contained in the first seed. This opinion supposes an infinite progression, and makes every individual a source of eternal generations. The

first

first seed, for instance, must have included all the plants of its species which have existed, or ever will exist; and the first man must have contained in his loins all the men who have appeared, or ever will appear, on the face of the earth. Every seed, and every animal, according to this doctrine, must have included in its own body an infinite posterity. If we yield to reasonings of this kind, we must lose sight of truth in the labyrinths of infinity; and, in place of solving, or of throwing light upon the question, we will involve it in tenfold obscurity. It is removing the object beyond the reach of our vision, and then complaining that it cannot be seen.

Let us investigate the nature of the ideas of infinite progression and expansion. How do we acquire them? In what do they instruct us? We derive the idea of infinity from the idea of what is limited. It is in this manner we obtain the ideas of infinite succession, and geometrical infinity: Every individual is a unit; several individuals make a limited number; and a whole species is to us an infinite multitude. From the same data by which we have demonstrated the nonentity of geometrical infinity, we might prove, that infinite succession, or propagation, rests on no firmer basis; that it is only an abstract idea, a mere deduction from the idea of finite objects, by lopping off the limits which necessarily terminate every magnitude *; and, of course, that every

* See this fully demonstrated in my preface to the French translation of Newton's fluxions, p. 7.

every opinion which infallibly leads to the idea of actual exiſtence, upon no better authority than what is derived from geometrical or numerical infinity, ought to be rejected.

The partizans of this opinion are now reduced to the neceſſity of acknowledging, that their infinity of ſucceſſion and of multiplication is only an indeterminable or indefinite number. But, ſay they, the firſt ſeed, of an elm, for example, which weighs not a grain, actually contains all the organic particles requiſite for the formation of this tree, and of all the individuals of the ſame ſpecies which ſhall ever appear. Is this a ſolution of the difficulty? Is it not cutting the knot, in place of untying it?

When, in reply to the queſtion, how beings are multiplied? it is anſwered, that the multiplication was completed in the creation of the firſt individuals, is not this both an acknowledgment of ignorance, and a renouncing of all deſire of farther improvement? We aſk how one being produces its like? and we receive for anſwer, that the whole was created at once. A ſtrange ſolution; for, whether one only or a thouſand generations had paſſed, the ſame difficulty remains, and, inſtead of removing it, the ſuppoſition of an indefinite number of germs, all exiſting and contained in a ſingle germ, increaſes and renders it altogether incomprehenſible.

I allow, that it is much eaſier to find fault, than to inveſtigate truth, and that the queſtion concerning

concerning reproduction is perhaps of ſuch a ſubtile nature, as not to admit of a full and ſatisfactory explication. But we ought at leaſt to inquire whether it be altogether inſcrutable; and, in the courſe of this inquiry, we will diſcover all that can be known, and the reaſon why we can know no more.

Queſtions or inquiries are of two kinds; the firſt regard primary cauſes, the other particular effects. If, for example, it be aſked why matter is impenetrable? we muſt either return no anſwer, or reply by ſaying, that matter is impenetrable, becauſe it is impenetrable. The ſame anſwer muſt be made, if we inquire into the cauſe of gravity, of extenſion, of the inertia of bodies, or of any general quality of matter. Such is the nature of all general and abſtract qualities, that, having no mode of comparing them with other objects in which they do not exiſt, we are totally incapable of reaſoning concerning them; and therefore all inquiries of this kind, as they exceed the powers of human intellect, are perfectly uſeleſs.

But, on the other hand, if the reaſon of particular effects be demanded, we are always in a condition to give a diſtinct anſwer, whenever we can ſhow that theſe effects are produced by one of the general cauſes; and the queſtion is equally ſolved, whether the particular effect proceeds immediately from a general cauſe, or from a chain

chain of ſucceſſive effects, provided we have a clear conception of the dependence of theſe effects upon each other, and of their mutual relations.

But, when a particular effect appears not to have any dependence upon more general effects, or has no analogy to thoſe already known, we are then totally unable to give any explication of ſuch effect; becauſe we have no ſimilar object with which it can be compared. We cannot explain a general cauſe, becauſe it equally exiſts in every object; and, on the contrary, we can give no account of a ſingle or iſolated effect; becauſe the ſame quality exiſts not in any other ſubject. To explain a general cauſe, we muſt diſcover one ſtill more general; but a ſingle and detached effect may be illuſtrated by the diſcovery of an analogous effect, which experience or accident may exhibit.

There is ſtill another kind of queſtion, which may be called a queſtion of fact. For example, why do trees, dogs, &c. exiſt? All queſtions of this kind are perfectly inſolvable; for thoſe who ſolve them by final cauſes conſider not that they miſtake the effect for the cauſe: The relation of particular objects to ourſelves has no connection with their origin. Moral affinity or fitneſs can never become a phyſical reaſon.

Queſtions in which we employ the word *Why*, ought to be carefully diſtinguiſhed from thoſe in in which we employ *How*, and ſtill more from thoſe in which we ought to uſe the words *how much* or *how many*. *Why* always relates to the cauſe of the effect,or to the effect itſelf; *how* relates to the manner in which the effect happens; and *how much* relates to the meaſure or quantity of the effect.

Theſe diſtinctions being eſtabliſhed, let us now examine the queſtion concerning the reproduction of beings. If it be demanded *why* animals and vegetables continue their ſpecies? we clearly perceive that this is a queſtion of fact, and therefore it is uſeleſs and inſolvable. But, if it be aſked *how* animals and vegetables are reproduced? we are enabled to ſolve the queſtion, by giving the hiſtory of the generation of every ſpecies of animal, and of the reproduction of every ſpecies of plant: After tracing, however, every poſſible method of propagation, and making the moſt exact obſervations, we have learned the facts only, but have not diſcovered the cauſes: And, as the means Nature employs in multiplying and containing the ſpecies, ſeem to have no relation to the effects produced, we are ſtill under the neceſſity of aſking, by what ſecret cauſe ſhe enables beings to propagate their kinds?

This queſtion is very different from the firſt and ſecond. It admits of nice ſcrutiny, and even allows us to employ the powers of imagination. It is, therefore, by no means inſolvable; for

for it belongs not to a general caufe. Neither is it folely a queftion of fact: And if we can conceive a method of reproduction, depending on primary caufes, or which, at leaft, is not repugnant to them, we ought to be fatisfied with it; and the more relation it has to the other effects of Nature, it will reft upon a firmer bafis.

By the nature of the queftion, then, we are permitted to form hypothefes, and to choofe that which appears to have the greateft analogy to the other phaenomena of nature. But we ought to reject every hypothefis which fuppofes the thing to be already accomplifhed; fuch, for example, as that which fuppofes the firft germ to contain all the germs of the fame fpecies, or that every reproduction is a new creation, an immediate effect of the will of the Deity; for all hypothefes of this kind are mere matters of fact, concerning which it is impoffible to reafon. We muft likewife reject every hypothefis which is founded on final caufes, fuch as, that reproduction is ordained in order to replace the living for the dead; that the earth may always be covered with vegetables and peopled with animals; that men may be fupplied with abundance of nourifhment, &c.; for fuch hypothefes, in place of explaining the effect by phyfical caufes, ftand on no other foundation than arbitrary relations and moral affinities. We ought, at the fame time, to defpife thofe general axioms and phyfical problems fo frequently and fo injudicioufly ly employed as principles by ſome philoſophers, ſuch as, 'Nulla foecundatio extra corpus;' every living creature proceeds from an egg; generation always ſuppoſes ſexes, &c. Theſe maxims muſt not be taken in an abſolute ſenſe; they ſignify no more than that the thing happens more commonly in this manner than in any other.

Let us then endeavour to find an hypotheſis that will be liable to none of theſe defects or incumbrances; and, if we ſhall not ſucceed in explaining the mechaniſm employed by Nature for the reproduction of beings, we ſhall, at leaſt, be able to approach nearer to the truth than we have hitherto reached.

In the ſame manner as we make moulds by which we can beſtow on the external parts of bodies whatever figure we pleaſe, let us ſuppoſe, that Nature can form moulds by which ſhe beſtows on bodies both an external and internal figure; would not this be one method by which reproduction might be effected?

Let us firſt conſider whether this ſuppoſition be well founded; let us examine whether it contains any thing that is abſurd or contradictory; and then we ſhall diſcover what conſequences may be drawn from it. Though our ſenſes reach not beyond the external parts of bodies, we have clear ideas of their different figures and external affections, and we can imitate Nature, by repreſenting external figures in

different

different ways, as by painting, by ſculpture, and by moulds. But, though our ſenſes be limited to external qualities, we know that bodies poſſeſs internal qualities, ſome of which are general, as gravity. This quality or power acts not in proportion to the ſurfaces, but to the maſſes, or the quantities of matter. Thus there are in Nature powers, and even of the moſt active kind, which penetrate the internal parts of matter. We are unable to form diſtinct ideas of ſuch qualities; becauſe, not being external, they fall not under the cogniſance of our ſenſes. But we can compare their effects, and may draw analogies from them, in order to account for the effects of ſimilar qualities.

If our eyes, inſtead of repreſenting to us the ſurfaces of bodies only, were ſo conſtructed as to perceive their internal parts alone, we ſhould then have clear ideas of the latter, without knowing any thing of the former. Upon this ſuppoſition, moulds for the internal conſtitution, which I have ſuppoſed to be employed by Nature, would be equally obvious and eaſy to conceive as moulds for the external figures of bodies; and we ſhould then be in a condition to imitate the internal parts of bodies, as we now imitate the external. Theſe internal moulds, though beyond our reach, may be in the poſſeſſion of Nature, as ſhe endows bodies with gravity, which penetrates every particle of matter. The ſuppoſition of internal moulds being thus

thus founded on analogy, let us next examine whether it involves any contradiction.

It may be alledged, that the expreſſion, *internal mould*, includes two oppoſite and contradictory ideas; for the idea of a *mould* relates only to the ſurface; but the idea of internal, as here employed, has a relation to the whole maſs; and therefore we might, with equal propriety, talk of a maſſy ſurface as of an internal mould.

I allow, that, when ideas are attempted to be repreſented which have never been expreſſed, we are ſometimes obliged to uſe terms that are apparently contradictory. To avoid this inconvenience, philoſophers have been accuſtomed to employ unuſual terms, inſtead of thoſe which have a received ſignification. But this artifice is of no uſe, when we can ſhow, that the ſeeming contradiction lies in the words, and not in the idea. A ſimple idea, however, cannot include a contradiction; *i. e.* whenever we can form an idea of a thing, if this idea be ſimple, it cannot be complex; it can include no other idea; and, of courſe, it can contain nothing that is oppoſite or contradictory.

Simple ideas are not only the firſt apprehenſions received by the ſenſes, but the firſt compariſons which we form of theſe apprehenſions: For the firſt apprehenſion is always the reſult of compariſon. The idea of the largeneſs or diſtance of an object neceſſarily implies a compariſon with bulk or diſtance in general. Thus, when an idea includes nothing more than comparifon, it ought to be regarded as fimple; and, confequently, it can contain nothing contradictory. The idea of an internal mould is of this fpecies. There is in nature a quality known by the name of gravity, which penetrates the internal parts of bodies. I underftand the idea of an internal mould to be relative to gravity; and, therefore, as it includes only a comparifon, it can imply no contradiction.

Let us now trace the confequences which may be drawn from this fuppofition; let us likewife inveftigate fuch facts as may correfpond with it; and the more analogies we can collect, the fuppofition will be rendered the more probable. We fhall begin with unfolding the idea of internal moulds; and then explain how it may lead us to conceive the mode of reproduction.

Nature, in general, appears to have a greater bias towards life than death: She feems anxious to organize bodies as much as poffible. Of this the multiplication of germs, which may be infinitely increafed, is a convincing proof; and it may be fafely affirmed, that, if all matter is not organized, it is only becaufe organized beings deftroy one another; for we can increafe at pleafure the number of animals and vegetables; but we cannot augment the quantity of ftones or of dead matter; which feems to indicate, that the moft ordinary and familiar operation of Nature

ture is the production of organized bodies; and here her power knows no limitation.

To render this idea more plain, we ſhall calculate what may be produced by a ſingle germ. The ſeed of an elm, which weighs not above the hundredth part of an ounce, will, in 100 years, form a tree, of which the maſs will amount to ten cubic fathoms. But, at the tenth year, this elm will have produced 1000 ſeeds, each of which, in 100 years more, will conſiſt of ten cubic fathoms. Thus, in the ſpace of 110 years, more than 10,000 cubic fathoms of organized matter are produced. Ten years after, we ſhall have ten million of fathoms, without including the annual increaſe of 10,000 which would amount to 100,000 more; and in ten years more, the number of cubick fathoms would be 10,000,000,000,000. Hence, in 130 years, a ſingle germ would produce a maſs of organized matter equal to 1000 cubic leagues; for a cubic league contains only about 10,000,000,000 cubic fathoms. Ten years after, this maſs would be increaſed to a thouſand times a thouſand leagues, or one million of cubic leagues; and in ten more it would amount to 1,000,000,000,000 cubic leagues; ſo that, in the ſpace of 150 years, the whole globe might be converted into organized matter of a ſingle ſpecies. Nature would know no bounds in the production of organized bodies, if her progreſs were not obſtructed by matter which is not ſuſceptible of organization; and this is a full demonſtration that ſhe has no tendency to increaſe brute matter; that her ſole object is the multiplication of organized beings; and that, in this operation, ſhe never ſtops but when irreſiſtible obſtacles occur. What we have remarked concerning the ſeed of an elm may be extended to any other germ; and it would be eaſy to ſhow, that, by hatching all the eggs which are produced by hens for a courſe of 30 years, the number of fowls would be ſo great as to cover the whole ſurface of the earth.

Calculations of this kind evince the tendency of Nature towards the production of organized bodies, and the facility with which ſhe performs the operation. But I will not ſtop here. Inſtead of dividing matter into *organized* and *brute matter*, the general diviſion ought to be into *living* and *dead matter*. That *brute matter* is nothing but matter produced by the *death* of animals and vegetables, might be proven from the enormous quantities of ſhells, and other relicks of living bodies, which conſtitute the principal parts of ſtones, marbles, clays, marls, earths, turfs, and other ſubſtances that are commonly reckoned *brute matter*, but are, in reality, compoſed of decayed animals and vegetables. This doctrine will be farther illuſtrated by the ſubſequent remarks, which appear to be well founded.

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The great facility and activity of Nature in the production of organized bodies, the existence of infinite numbers of organic particles which constitute life, have been already shown. We now proceed to inquire into the principal causes of death and destruction. In general, beings which have a power of converting matter into their own substances, or of assimilating the parts of other beings, are the greatest destroyers. Fire, for example, which converts almost every species of matter into its own substance, is the greatest source of destruction that we are acquainted with. Animals seem to partake of the nature of flame; their internal heat is a species of fire approaching to flame. Accordingly, animals are the greatest destroyers; and they assimilate and convert into their own substance all bodies which can serve them for nourishment. But, though these two causes of destruction be considerable, and their effects tend perpetually to the destruction of organized bodies, the cause of reproduction is infinitely more active and powerful. It even seems to derive, from destruction itself, fresh powers of multiplying; for assimilation, which is one cause of death, is, at the same time, a necessary mean of producing life.

The destruction of organized bodies, as has been remarked, is only a separation of the organic particles of which they are composed. These particles continue separate till they be again united by ſome active power. But what is this power? It is the power, poſſeſſed by animals and vegetables, of aſſimilating the matter of their food; and is not this the ſame, or nearly connected with the ſame power which is the cauſe of reproduction?

CHAP.

CHAP. III.

Of Nutrition and Growth.

AN animal body is a kind of internal mould, in which the nutritive matter is ſo aſſimilated to the whole, that, without changing the order or proportion of the parts, each part receives an augmentation. This increaſe of bulk has, by ſome philoſophers, been called an expanſion or unfolding of the parts; becauſe they fancied they had accounted for the phaenomenon, by telling us, that the form of an animal in embryo was the ſame as at full maturity, and that, therefore, it was eaſy to conceive how its parts ſhould be proportionally unfolded and augmented by the addition of acceſſory matter.

But, how can we have a clear idea of this augmentation or expanſion, if we conſider not the bodies of animals, and each of their parts, as ſo many internal moulds which receive the acceſſory matter in the order that reſults from their poſition and ſtructure? This expanſion cannot be effected ſolely by an addition to the ſurfaces, but, on the contrary, by an intus-ſuſception, or by penetrating the whole maſs; for the ſize of the

the part is augmented proportionally, without changing its form. Hence it is neceſſary, that the increaſing matter muſt, in ſome manner or other, intimately penetrate the whole part in all its dimenſions: It is equally neceſſary, that this penetration ſhould be effected in a fixed order and proportion, ſo that no internal point receive more matter than another; otherwiſe ſome parts would be more quickly unfolded than others, which would entirely change their figure. What can thus regulate the acceſſory matter, and force it to arrive equally and proportinally to every internal point of the body, if we have not recourſe to an internal mould?

The bodies of animals and of vegetables, therefore, conſiſt of internal moulds, which uniformly preſerve the ſame figure. But their maſſes may receive a proportional increaſe, by the expanſion of the moulds in all their dimenſions, both internal and external; and this expanſion is effected by an intus-ſuſception of an acceſſory and foreign matter, which intimately penetrates the whole, and aſſumes the ſame form and identity of ſubſtance with the matter of the moulds themſelves.

But what is the nature of that matter which an animal, or a vegetable, aſſimilates to its own ſubſtance? What beſtows on it that force and activity which enables it to penetrate the internal mould? If ſuch a power exiſts, muſt it not

be

be ſimilar to that by which the mould itſelf is capable of being reproduced?

Theſe three queſtions include the whole ſubject, and appear to depend on one another; for it is impoſſible to explain, in a ſatisfactory manner, the reproduction of animals or vegetables, if we have not a clear idea how the operation of nutrition is performed. Each queſtion, therefore, demands a ſeparate examination, that we may be enabled to compare their reſults.

The firſt, which regards the nature and qualities of the nutritive matter, is in part reſolved by the preceding reaſonings, and ſhall be clearly unfolded in the ſubſequent chapters. We ſhall ſhow, that there are in Nature infinite numbers of living organic particles; that Nature produces them without any expence, becauſe their exiſtence is conſtant and invariable; that the cauſes of death diſunite theſe particles only, but do not deſtroy them. Thus the matter aſſimilated by an animal or vegetable, is an organic matter of the ſame nature with that of the animal or vegetable, and, conſequently, may augment the ſize without changing the figure or the qualities of the original moulds; becauſe it has the ſame qualities and the ſame form with the matter of which the moulds themſelves are compoſed. Of the quantity of aliment taken by an animal to ſupport its life, and to maintain the vigour of its organs, and of the juices abſorbed by the roots and leaves of a plant, a great part

part is rejected by transſpiration, by ſecretions, and by other excretories; and a ſmall portion only is retained for the nouriſhment and expanſion of the parts. It is extremely probable, that, in the bodies of animals and of vegetables, a ſeparation is made between the *brute* particles of the aliment and the organic; that the former are carried off by the methods juſt mentioned; that nothing but the organic particles remain; and that they are diſtributed, by means of ſome active power, to the different parts, in a proportion ſo exact, that neither more nor fewer are applied than anſwer the purpoſes of nutrition, and of an equal growth and expanſion.

As to the ſecond queſtion, What is the nature of that active power, which enables the organic matter to penetrate and combine with the internal mould? It is apparent, from the preceding chapter, that powers exiſt in Nature, like that of gravity, which affect the moſt internal parts of matter, without having the ſmalleſt relation to its external qualities. Theſe powers, as formerly obſerved, are beyond the reach of our ſenſes; becauſe their action is exerted upon the intimate ſtructure of bodies. It is evident, therefore, that we can never obtain a clear idea of them, nor of their mode of acting. Their exiſtence, however, is not leſs certain, than that, by means of them, moſt natural effects are produced, eſpecially thoſe of nutrition and expanſion, which muſt be owing to a cauſe that penetrates the

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moſt intimate receſſes of the original moulds; for, in the ſame manner as gravity pervades the whole parts of matter, the power which puſhes forward or attracts the organic particles of food, penetrates the internal parts of organized bodies; and, as theſe bodies have a certain form, which we have diſtinguiſhed by the appellation of *internal moulds*, the organic particles, puſhed on by the action of this penetrating force, muſt enter in an order relative to this form, and conſequently cannot alter its figure, but only augment its bulk, and give riſe to the growth and expanſion of organized bodies: And if, in the organized body, thus expanded, there be ſome particles ſimilar to the whole, both internally and externally, theſe parts will become the ſource of reproduction.

Let us now examine the third queſtion, namely, Is it not by a ſimilar power that the internal mould itſelf is reproduced? This power appears to be not only ſimilar, but the very ſame with that which is the cauſe of expanſion and reproduction; for, in an organized and expanded body, nothing farther is neceſſary for the reproduction of a new body ſimilar to itſelf, than that it ſhould contain ſome particle every way ſimilar to the whole. This particle, at its firſt ſeparation, will not preſent to our eyes a ſenſible figure by which we can compare it with the whole body. But, when ſeparated from the body, and put in a ſituation to receive proper nouriſhment, this ſimilar

lar particle will begin to expand and to exhibit the form of an entire and independent being, of the ſame ſpecies with that from which it was detached. Thus, a willow or a polypus, as they contain a larger proportion of particles ſimilar to the whole, than moſt other ſubſtances, when cut into any indefinite number of pieces, each ſegment becomes a new body ſimilar to the parent from which it was ſeparated.

Now, in a body of which all the particles are ſimilar to itſelf, the organization is the moſt ſimple, as has been remarked in the firſt chapter; for it is only a repetition of the ſame form, a congeries of figures, ſimilarly organized. It is for this reaſon that the moſt ſimple bodies, the moſt imperfect ſpecies, are moſt eaſily and moſt abundantly reproduced. But, if an organized body contain only few particles ſimilar to itſelf, as theſe alone are capable of a ſecond expanſion, its power of reproducing will be both more difficult, and more circumſcribed as to the number produced. The organization of bodies of this laſt kind is alſo more complex, becauſe it poſſeſſes fewer parts which are ſimilar to the whole; and, therefore, the more perfectly a body is organized, its power of reproduction will be proportionally diminiſhed.

In this manner we diſcover nouriſhment, growth, and propagation, to be effects of the ſame cauſe. Organized bodies are nouriſhed by the particles of aliment which are ſimilar to them; they

they grow or are expended by abſorbing thoſe organic particles which correſpond to their own nature; and they propagate, becauſe they contain ſome organic particles ſimilar to themſelves. It only remains to examine whether theſe ſimilar organic particles are extracted from the food, or have a primary and independent exiſtence in the bodies themſelves. If we ſuppoſe the latter, we recur to the infinity of ſimilar parts or germs contained within each other, an hypotheſis which we have already ſhown to be replete with difficulties and abſurdities. We muſt, therefore, maintain, that the ſimilar parts are extracted from the food; and, after what has been ſaid on the ſubject, we hope to be able to explain the manner of their abſorption, and how the more minute organic particles which compoſe them are united.

We formerly remarked, that the organic parts of food were ſeparated from thoſe which have no analogy to the animal or vegetable, by tranſpiration and other excretions. The firſt remain, and ſerve to expand and nouriſh the body: But theſe organic parts muſt be of very different ſpecies; and, as each part of the body receives only a proper number of thoſe which correſpond to it, the ſurplus, it is natural to imagine, will be returned from all parts of the body, and be collected in one or more reſervoirs, where they will unite and form ſmall organic bodies ſimilar to the firſt, and which require nothing but pro-

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per circumſtances for expanding and becoming new individuals of the ſame ſpecies; for, as all parts of the body ſend off organic particles ſimilar to thoſe of which themſelves are compoſed, the reſult of their union muſt be the production of new organized bodies ſimilar to the original. Hence we may conclude, that this is the reaſon why organized bodies, during the time of their growth and expanſion, are ſeldom or never capable of reproducing; becauſe the growing parts abſorb the whole organic particles preſented to them, and no ſurplus being ſent from the different parts of the body, propagation becomes, of courſe, impracticable.

This account of nutrition, and of reproduction, will not, perhaps, be received by thoſe philoſophers who admit only a certain number of mechanical principles, and reject every thing as falſe which depends not upon them; and, as the explication now given of nutrition and reproduction has no connection with any of theſe principles, they will conclude that it deſerves no credit. But I think very differently from theſe philoſophers. In admitting only a few mechanical principles, they conſider not how much they contract the bounds of philoſophy, and how few phaenomena can, by this narrow method of thinking, be fully explored.

The notion of explaining all the appearances in Nature upon the principles of mechaniſm, is, doubtleſs, a great exertion, and was firſt attempt-

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ed by Des Cartes. But it is, at least, an untenible project; and, though it were otherwise, we are unable to put it in execution. These mechanical principles are, the extension of matter, its impenetrability, its motion, its external figure, its divisibility, the communication of motion by impulse, by the action of springs, &c. These ideas we have acquired by our senses, and we regard them as principles, because they are general and common to all matter. But are we certain that matter possesses no other qualities? Ought we not rather to believe that these qualities, which we assume for principles, are only modes of perception; and that, if the conformation of our senses were different, we would recognize qualities in matter very different from those above enumerated? It is presumptuous to deny every quality to matter but those we are acquainted with. Many general qualities, perhaps, remain to be discovered; and many may exist which will for ever elude human discernment. The cause of impulsion, of cohesion, or of any other mechanical principle, will always continue to be equally inscrutable as that of attraction, or of any other general quality. Hence it may be concluded, that mechanical principles are nothing else than general effects which experience has enabled us to remark in matter; and that, whenever we shall discover, either by reflection, by analogy, or by experience, a new general effect, it will become a new mechanical principle,

principle, which may be employed with equal advantage and certainty as any of thoſe that are already known.

The defect of Ariſtotle's philoſophy was the employing particular effects as cauſes; and that of Des Cartes conſiſts in the rejection of every cauſe, but a few general effects. To uſe nothing as cauſes but general effects, to endeavour to augment the number of theſe, and to attempt to generalize particular effects, would conſtitute the moſt perfect principles of genuine philoſophy.

In my theory of expanſion and reproduction, I firſt admit the mechanical principles, then the penetrating force of gravity, and, from analogy and experience, I have concluded the exiſtence of other penetrating forces peculiar to organized bodies. I have proved by facts, that matter has a ſtrong tendency towards organization; and that there are in Nature an infinite number of organic particles. I have, therefore, only generalized particular obſervations, without advancing any thing contrary to mechanical principles, when that term is uſed in its proper ſenſe, as denoting the general effects of Nature.

CHAP.

CHAP. IV.

Of the Generation of Animals.

AS the organization of man, and of other animals, is the most perfect, and the most complex, the propagation of them is likewise most difficult, and the number of individuals is less abundant. I except here such animals as can be multiplied by a separation of their parts, or without the aid of generation, these having been sufficiently treated of in the preceding chapter *.

But how will the theory delivered in the former chapter apply to the generation of men, and other animals, who are distinguished by sexes? We understand, from what has been said, how every individual may reproduce; but we cannot conceive how two individuals, the one a male, and the other a female, should uniformly produce a third.

Before replying to this objection, I must observe, that the writers on this subject have confined their ideas solely to the generation of men and of animals, without attending to the nature of

* Here the Author gives an unnecessary recapitulation of Chap. III. to which the reader is referred.

of reproduction in general: And as the generation of animals is the most complicated species of reproduction, they have laboured under great disadvantages, not only by attacking the most difficult point, but by leaving themselves no subject of comparison to enable them to illustrate the question. To this circumstance I chiefly attribute the unsuccessfulness of their attempts. But, by the method I have observed, I am persuaded that I shall be able to give a satisfactory explanation of every species of reproduction.

Let the generation of man serve as an example. To begin with infancy:

The expansion and growth of the different parts of man's body being effected by the intimate penetration of organic particles, analogous to each of these parts, all the organic particles, in early life, are absorbed, and entirely employed in unfolding and augmenting his different members. He has, of course, little or no superfluous particles, till his growth be completed. It is for this reason that infants are incapable of propagating. But, when man's body has nearly attained its full size, he requires not the same quantity of organic particles; the surplus is, therefore, sent from all parts into reservoirs destined for their reception. These reservoirs are the testes and seminal vessels. At this very period, when the growth of the body is nearly finished, puberty commences, and every phaenomenon attending it discovers a superabundance

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of nouriſhment: The voice changes into a deeper tone; the beard begins to appear, and other parts of the body are covered with hair; the parts deſtined for generation are ſuddenly expanded; the ſeminal fluid fills the reſervoirs prepared for its reception, and ſpontaneouſly eſcapes from the body during ſleep. This ſuperabundance is ſtill more evident in the female: It diſcovers itſelf by a periodic evacuation, which begins and terminates with the faculty of propagating; by a quick increaſe of the breaſts; and by a change in the ſexual parts, which ſhall be afterwards explained *.

I conceive, then, that the organic particles ſent from all parts of the body into the teſticles and ſeminal veſſels of the male, and into the ovarium of the female, compoſe the ſeminal fluid which, in either ſex, as formerly obſerved, is a kind of extract from the ſeveral parts of the body. Theſe organic particles, inſtead of uniting and forming an individual ſimilar to that in whoſe body they are contained, as happens in vegetables, and ſome imperfect animals, cannot accompliſh this end without a mixture of the fluids of both ſexes. When this mixture is made, if the organic particles of the male exceed thoſe of the female, the reſult is a male; and if thoſe of the female abound moſt, a female is generated. I mean not that the organic particles of the male or of the female could ſingly produce

 individuals;

* See below the Nat. Hiſt. of Man, chap. 2.

individuals: A concurrence or union of both is requiſite to accompliſh this end. Thoſe ſmall moving bodies, called *ſpermatic animals*, which, by the aſſiſtance of the microſcope, are ſeen in the ſeminal fluids of all male animals, are, perhaps, organized ſubſtances proceeding from the individual which contains them; but, of themſelves, they are incapable of expanſion, or of becoming animals ſimilar to thoſe in whom they exiſt. We ſhall afterwards demonſtrate, that there are ſimilar animalcules in the ſeminal fluids of females, and point out the place where this fluid is to be found.

It is probable, that theſe organic bodies are only the firſt rudiments of an animal, containing nothing but its eſſential parts. We ſhall not enter into a detail of proofs on this ſubject, but content ourſelves with remarking, that the organization of theſe pretended ſpermatic animals may be very imperfect; or rather, that they are the living organic particles mentioned above, which are common both to vegetables and to animals; or, at moſt, that they are only the firſt junction of theſe particles.

But, to return to our ſubject. It may be aſked, how is it poſſible that the ſuperfluous organic particles ſhould be detached from all parts of the body, and unite upon the mixture of the male and female fluids? Beſides, are we certain that ſuch a mixture takes place? Has it not been maintained, that the female furniſhes no fluid of the this kind? Is it an eſtabliſhed fact, that the male fluid enters the uterus? &c.

To the firſt queſtion I reply, that, if what I had ſaid concerning the penetration of the internal mould by the organic particles, in growth and nutrition, had been properly underſtood, it would be eaſy to conceive, that, when theſe particles are unable to penetrate the parts into which they formerly entered, they muſt take another route, and, of courſe, arrive at ſome other part, as the teſticles and ſeminal veſſels. Every attempt to explain the animal oeconomy, and the various motions of the human body, by mechanical principles alone, muſt be vain and ineffectual; for it is evident, that the circulation of the blood, muſcular motion, and other functions of an animated body, cannot be accounted for by impulſion, or by any of the common laws of mechaniſm. It is equally evident, that growth and reproduction are effects of laws of a different nature. Why, then, do we refuſe the exiſtence of penetrating forces which act upon the whole ſubſtances of bodies, when we have examples of ſuch powers in gravity, in magnetic attraction, in chemical affinities? Since, therefore, we are aſſured by facts, and by a number of conſtant and uniform obſervations, that there are powers in nature which act not by impulſion, why are not theſe powers ranked among mechanical principles? Why do we reject them in the explanation of effects which they are known to produce? Why are we desirous of employing the power of compulsion only? Is not this equally absurd as to judge of painting by the touch; to explain the phaenomena which belong to the mass by those that relate only to the surface; or to use one sense in place of another? It is limiting the reasoning faculty to a small number of mechanical principles, which are by no means sufficient to explain the various effects of Nature.

But, if these penetrating forces be admitted, is it not natural to imagine, that those particles which are most analogous to one another will unite in the most intimate manner; that each part of the body will appropriate those which are most agreeable to its nature; and that the whole superfluous particles will form a seminal fluid, which shall contain all the organic particles necessary for forming a small organized body, similar in every respect to that from which the fluid is extracted? May not a force similar to that which is the cause of growth, be sufficient to collect the superfluous organic particles, and bestow on them the figure of the body from which they proceed?

That our food contains an immense number of organic particles, requires no formal proof; since we are solely nourished by animals and vegetables, which are organized substances. In the stomach and intestines, the gross parts of the aliment are separated and rejected by the excretories.

tories. The chyle, which is a purer part of the aliment, is abſorbed by the lacteal veſſels; from thence it is carried into the maſs of blood, and, in the courſe of circulation, it is more and more refined, the unorganic and uſeleſs particles being thrown out by tranſpiration and other ſecretions: But the organic particles are retained, becauſe they are analogous to the blood, and are attracted by it. Hence, as the whole maſs of blood paſſes ſeveral times through the body, during the courſe of this perpetual circulation, I ſuppoſe, that each particular part attracts thoſe particles which are moſt analogous to it, and allows the reſt to move on. In this manner all the parts are nouriſhed and unfolded, not, as is commonly imagined, by a ſimple addition of matter to their ſurfaces, but by an intimate penetration of ſubſtance, effected by a force which acts equally upon every point of the whole maſs: And, after the different parts have acquired their utmoſt growth, and are fully impregnated with ſimilar organic particles, as their ſubſtance becomes then more denſe and ſolid, I imagine that they loſe their faculty of attracting and receiving the particles preſented to them. But, as the particles continue to be carried round in the courſe of the circulation, and are no longer abſorbed in ſuch quantities as formerly, they muſt, of neceſſity, be depoſited in ſome particular reſervoir, ſuch as the teſticles and ſeminal veſſels. When this fluid extract of the male is mixed with

with that of the female, the particles which are moſt analogous to each other, being actuated by a penetrating force, unite and form a ſmall organized body, ſimilar to the one or the other ſex; and this body, when once formed, requires only an expanſion of its parts, an operation which is performed in the womb of the mother.

We ſhall now conſider the ſecond queſtion, namely, Whether the female has a ſeminal fluid ſimilar to that of the male? In the *firſt* place, though ſuch a fluid exiſts in females, the mode of emiſſion is very different from that of the male, being generally confined within the body *. The ancients were ſo confident of the exiſtence of a female fluid, that they diſtinguiſhed the two ſexes by their different modes of emiſſion. But thoſe phyſicians who attempt to explain generation by eggs, or by ſpermatic animalcules, inſiſt, that females have no peculiar fluid; that the mucus iſſuing from the parts has been miſtaken for a ſeminal fluid; and that the opinion of the ancients on this ſubject is deſtitute of foundation. This fluid, however, does exiſt; and the doubts concerning it have ariſen ſolely from attachment to ſyſtems, and from the difficulty of diſcovering its reſervoir. The fluid which is ſeparated from the glands about the neck and orifice of the uterus, has no viſible reſervoir; and, as it flows out of the body, it is natural to think that it is not

* Quod intra ſe ſemen jacit, foemina vocatur; quod in hac jacit, mas; *Ariſtot. de animalibus, art.* 18.

not the prolific fluid, becauſe it cannot co-operate in the formation of the foetus, which is performed within the uterus. The reſervoir for the prolific fluid of the female, therefore, muſt be ſituated in a different part: It even flows abundantly; though, like that of the male, a ſmall quantity is ſufficient to produce a foetus. If a little of the male fluid enters the uterus, either by its orifice or by abſorption, and meets with the ſmalleſt drop of the female fluid, it is ſufficient for the purpoſe of propagation. Thus, neither the obſervations of ſome anatomiſts, who maintain that the ſeminal fluid of the male can have no admiſſion into the uterus, nor the oppoſite opinion maintained by their antagoniſts, have any influence upon the theory we are endeavouring to eſtabliſh. But the diſcuſſion of theſe points we leave to a future opportunity.

Having obviated ſuch objections as might be made, let us attend to the evidences which concur in ſupporting our hypotheſis. The firſt ariſes from the analogy between growth and reproduction. It is impoſſible to give a ſatisfactory account of growth or expanſion, without having recourſe to thoſe penetrating forces, thoſe affinities or attractions which we employed in explaining the formation of the ſmall organic bodies, that are ſimilar to the large bodies which contain them. A ſecond analogy is derived from this circumſtance, that both nutrition and reproduction proceed, not only from the ſame efficient,

cient, but from the ſame material cauſe, namely, the organic particles of food; and what proves the ſurplus of the nutritive particles to be the cauſe of reproduction, is, that the body is not in a condition to propagate till its growth be finiſhed: Of this we have daily examples, in dogs and other animals, who follow, more cloſely than we do, the laws of Nature: They have no inclination to propagate till they have nearly attained their full growth; and by this we know whether the growth of a dog be finiſhed; for he ſeldom grows after being in a condition to generate.

Another proof that the ſeminal fluid is formed of the ſurplus of the nutritive particles, ariſes from the condition of eunuchs and other mutilated animals: In this unnatural ſtate, animals grow fatter than thoſe who retain all their parts. The ſuperabundance of nutriment, having no organs for its evacuation, changes the whole habit of their bodies. The knees and haunches of eunuchs grow uncommonly large. The reaſon is evident. After their bodies have acquired the common ſize, if the ſuperfluous organic particles found an iſſue, as in other men, the growth would proceed no farther. But, as they want organs for emitting the ſeminal fluid, which is nothing but the ſuperfluous nutritive particles, it remains in the body, and has a conſtant tendency to expand the parts beyond their natural ſize. Now, bones, it is well known, grow or extend

extend by their extremities, which are ſoft and ſpongy, and, when they have once acquired ſolidity, they are incapable of farther extenſion: Hence the ſuperfluous organic particles can only enlarge the ſpongy extremities of bones; and this is the reaſon why the haunches, knees, &c. of eunuchs augment to a diſproportioned bulk.

But the ſtrongeſt proof of the truth of our preſent doctrine ariſes from the reſemblance of children to their parents. Sons, in general, reſemble their fathers more than their mothers, and daughters have a greater reſemblance to their mothers than their fathers; becauſe, with regard to the general habit of body, a man reſembles a man more than a woman, and a woman reſembles a woman more than a man. But, as to particular features or habits, children ſometimes reſemble the father, ſometimes the mother, and ſometimes both. A child, for example, will have the eyes of the father, and the mouth of the mother, or the colour of the mother and the ſtature of the father. Of ſuch phaenomena it is impoſſible to give any explication, unleſs we admit that both parents have contributed to the formation of the child, and, conſequently, that there has been a mixture of two ſeminal fluids.

Theſe reſemblances long embarraſſed me, and, till I had maturely conſidered the ſubject of generation, led me into many errors and prejudices: And it was not without much thought, a minute examination

examination of a great number of families, and a multiplicity of evidence, that I could prevail on myſelf to alter my former opinion, and to embrace what I now believe to be truth. But the objections which might occur concerning mulattoes, mongrels, mules, and particular parental reſemblances, inſtead of oppoſing my theory, I deſpair not of being able to ſhow that they beſtow on it an additional ſtrength.

In youth, the ſeminal fluid is leſs copious, but more ſtimulating. Its quantity continues to augment till a certain age; becauſe, in proportion as we approach that age, the parts of the body become more ſolid, admit fewer nutritive particles, ſend back more of them to the common reſervoirs, and, of courſe, augment the quantity of the ſeminal fluid. Thus, if the external organs have not been uſed, middle-aged men, or even old men, procreate with more eaſe than young men. This is evidently the caſe with the vegetable tribes: A tree, the older it is, produces the greater quantity of fruit.

Young people, who, by forced irritations, determine an unnatural quantity of this fluid into the reſervoirs prepared for its reception, immediately ceaſe to grow, loſe their fleſh, and at laſt fall into conſumptions. The reaſon is apparent: They loſe, by premature and too frequent evacuations, the very ſubſtance which Nature intended for the nouriſhment and growth of their bodies.

Men

Men who are thin, but not emaciated, and thoſe who are plump, but not fat, are the moſt vigorous. Whenever the ſuperabundant nutritive particles begin to form fat, it is always at the expence of the ſeminal fluid and other generative powers. When the growth of the different parts of the body is complete, when the bones have acquired full ſolidity, when the cartilages begin to oſſify, and, laſtly, when the parts almoſt refuſe the admiſſion of nutritive particles, then the fat augments conſiderably, and the quantity of ſeminal fluid diminiſhes; becauſe the nutritive particles, inſtead of being ſent back to the reſervoirs, are arreſted in every part of the body.

The quantity of ſeminal fluid not only increaſes till we arrive at a certain age, but it becomes more thick. It contains, in the ſame bounds, a greater quantity of matter. Its ſpecific gravity is nearly double that of the blood; and, of courſe, it is heavier than any other animal fluid.

To a man in health, an evacuation of this fluid whets the appetite: He ſoon finds the neceſſity of repairing the loſs by freſh nouriſhment. Hence we may conclude, that abſtinence and hunger are the moſt effectual checks to luxury of every kind.

Many other remarks might be made on this ſubject, which muſt be deferred till we come to treat of the hiſtory of man: We ſhall, therefore,

conclude

conclude with a few obſervations. Moſt animals diſcover no inclination for the ſexes till their growth be nearly finiſhed: Thoſe which have but one ſeaſon in the year, have no ſeminal fluid, except at that time. Mr Needham * not only ſaw this liquor forming in the milt of the *Calmar*, but likewiſe the ſpermatic animals, and the milt itſelf, which have no exiſtence till the month of October, when this fiſh ſpawns on the coaſts of Portugal, where Needham made the obſervation. After the ſpawning time is over, the ſeminal liquor, the ſpermatic animals, and the milt, dry up and totally diſappear; till the ſame ſeaſon returns next year, when the ſuperfluous nutritive particles renew the milt as formerly. The hiſtory of the deer will furniſh us with an opportunity of remarking the various effects of rutting, the moſt conſpicuous of which is the extenuation of the animal; and, in thoſe ſpecies of animals whoſe rutting and ſpawning happens but once in a year, the extenuation of their bodies is proportionally great.

As women are ſmaller and weaker than men, as their conſtitutions are more delicate, and, as they take leſs food, it is natural to think that their ſuperfluous organic particles ſhould alſo be leſs abundant: Of courſe, their ſeminal fluid will be weaker and ſmaller in quantity than that of men; and, ſince the fluid of females contains fewer organic particles, muſt not a greater number

* See Needh. new microſcopical diſcoveries, London 1745.

ber of males than of females refult from a mixture of thefe two fluids? This is really the cafe; and to account for it has hitherto been deemed impoffible. The number of males born exceeds that of females about a fixteenth part; and we fhall afterwards fee that the fame effect is produced by the fame caufe in all the different fpecies of animals.

CHAP. V.

Examination of the different Syſtems of Generation.

PLATO, in the Timaeus, accounts not only for the generation of men, of animals, of plants, and of the elements, but even of the heavens and of the gods themſelves, by images reflected or extracted from the divine Creator; which images, by an harmonic movement, are arranged in the moſt perfect order, according to the properties of number. The univerſe, he ſays, is a copy of the Deity; time, ſpace, motion, and matter, are the images or repreſentations of his attributes; and ſecondary and particular cauſes are reſults of the numeric and harmonic qualities of theſe images: The world, from its excellency, is the moſt perfect animated being. To give the world complete perfection, it was neceſſary that it ſhould contain all the other animals, or all the poſſible forms and repreſentations of the creative power. Man is one of theſe forms. The eſſence of all generation conſiſts in the unity and harmony of the number Three, or of the Triangle, namely, that which generates, that in which generation is performed, and the reſult, or that which is generated. The ſucceſſion of individuals in the ſpecies,

ſpecies, is only a fugitive image of the immutable eternity of this harmonic triangle, a univerſal prototype of all exiſtences, and of all generations.

This philoſopher paints only ideas. Diſengaged from matter, he flies into the regions of abſtraction; and, loſing ſight of ſenſible objects, he contemplates thoſe of intellect alone. One cauſe, one end, one mean, compoſe the whole of his perceptions: God is the cauſe, perfection the end, and harmonic repreſentations the means. This idea is ſublime; the mode of philoſophiſing is noble and full of ſimplicity; but it is perfectly vacant, and affords no objects for ſpeculation. We are not pure intelligences. We are unable to give real exiſtence to our ideas. Chained to matter, or rather depending on the cauſes of our ſenſations, it is impoſſible that we ſhould realiſe abſtractions. To Plato I might reply in his own manner, 'The Creator realiſes 'every thing he conceives; his perceptions be'get exiſtence: The created being, on the con'trary, conceives nothing but by retrenching 'from reality; and annihilation is neceſſary to 'bring forth his ideas.'

Let us, without regret, therefore, confine ourſelves to a philoſophy more humble and more material; and, keeping within the ſphere which nature has allotted us, let us examine thoſe rapid and daring ſpirits who attempt, though in vain, to fly beyond the limits of humanity. The whole of this Pythagorean philoſophy, which is purely intellectual, depends upon two principles, the one falſe, and the other uncertain; namely, the real power of abſtraction, and the natural exiſtence of final cauſes. To apprehend numbers to be real beings; to ſay that unity is a general individual, which not only repreſents all individuals, but even communicates exiſtence to them; to pretend that unity exerciſes the actual power of engendering another unity nearly reſembling itſelf, and of creating two individuals, two ſides of a triangle, that can have no connection or perfection without a third ſide, which is neceſſarily produced by the other two; in fine, to regard numbers, geometrical lines, and metaphyſical abſtractions, as real and efficient phyſical cauſes, by which the elements are formed, plants and animals regenerated, and all the phaenomena of Nature produced, appears to be a moſt abſurd abuſe of human reaſon, and an invincible obſtacle to the advancement of knowledge. Beſides, nothing can be more fallacious than ſuch chimeras. Suppoſing we ſhould agree with Plato and Malbranche, that matter has no exiſtence, that external objects are only ideal images of the creative power, and that we ſee every thing in the Deity himſelf; does it follow, that our ideas are of the ſame order with thoſe of the Creator, and that they can produce real exiſtences? Are we not dependent on our ſenſations? Whether the objects which excite ſenſations

ſenſations be real or imaginary, whether they exiſt without or within, whether it be God or matter that we every where behold, is to us of little importance: We are not leſs certain of being uniformly affected in the ſame manner by the ſame cauſes. The relations between our ſenſes and the objects which affect them are neceſſary and invariable. It is upon this baſis alone that the principles of philoſophy ought to be founded, otherwiſe our knowledge muſt be uſeleſs and fallacious. Can an harmonic triangle create the ſubſtance of the elements? Is fire, as Plato affirms, an acute triangle, and light and heat two properties of this triangle? Are water and air rectangular and equilateral triangles? Is the form of the element of earth a ſquare, becauſe, being the leaſt perfect of the four elements, it recedes as far as poſſible from a triangle, without departing altogether from its eſſence? Do males and females embrace each other for no other purpoſe but to complete the triangle of generation? Theſe Platonic ideas have two different aſpects: In ſpeculation, they ſeem to proceed from ſublime principles; but the application of them in practice leads to nothing but falſe and childiſh concluſions.

Is it difficult to perceive that our ideas originate from our ſenſes alone; that the objects we regard as real exiſtences are thoſe concerning which the ſenſes uniformly give the ſame teſtimony; that the objects we apprehend as having a real existence, are those which are invariably presented to us in the same manner; that the mode in which they present themselves has no dependence upon our will or inclination; that, of course, our ideas, instead of being the causes of things, are only particular effects, which become less similar to the objects themselves, in proportion as they are rendered more general; and, lastly, that mental abstractions are only negative beings, which derive their intellectual existence from the faculty we possess of considering objects, without regarding their sensible qualities?

Is it not, therefore, apparent, that abstract ideas can never be the principles of existence, or of real knowledge? On the contrary, all our knowledge is derived from comparing and arranging the results of our sensations. These results are known by the appellation of *experience*, the only source of genuine science. The employment of any other principle is an abuse; and every edifice founded upon abstract ideas, is a temple erected to Error.

In philosophy, error has a more extensive influence than in morals. A thing may be false in morals solely because it is misrepresented. But falsehood in metaphysics consists not in misrepresentation alone, but in taking for granted what has no existence at all. It is into this most pernicious species of error that the Platonists and the

the Sceptics have fallen. Their falſe ſuppoſitions have obſcured the natural light of truth, bewildered the reaſoning faculties of men, and retarded the progreſs of philoſophy.

Final cauſes are employed as a ſecond principle by Plato and other theoriſts. This principle has even been adopted by the vulgar, and by ſome modern philoſophers. A moment's reflection, however, will be ſufficient to reduce this principle to its proper value. To ſay that light exiſts becauſe we have eyes, and that ſounds exiſt becauſe we have ears; or to ſay that we have eyes and ears, becauſe light and ſounds exiſt; is not this preciſely the ſame thing? or, rather, are we any wiſer by this kind of reaſoning? Will we ever make any diſcoveries by ſuch a mode of explication? Is it not apparent, that final cauſes are only arbitrary relations and moral abſtractions, which ought to have leſs influence than abſtractions in metaphyſics, becauſe the origin of the former is leſs noble and worſe imagined? And, though Leibnitz has endeavoured to give an elevation to final cauſes, under the appellation of the reaſonableneſs and eternal fitneſs of things, [*raiſon ſuffiſante*], and Plato has repreſented them under the flattering picture of abſolute perfection; all theſe efforts are inſufficient to cover their native inſignificance and precariouſneſs. Are we better inſtructed in the operations of Nature, becauſe we are told that nothing exiſts without a reaſon, or that every thing is created with a view to the perfection of the whole? What is reasonableness or fitness? What is perfection? Are they not moral beings, created solely by the human intellect? Are they not arbitrary relations which we have contrived to generalise? They have no foundation but in moral affinities, which, so far from producing any physical or real existence, change the nature of truth, and confound the objects of our sensations, of our perceptions, and of our understandings, with those of our sentiments, of our passions, and of our wills *.

Much

* The translator thinks it his duty to apprise the reader, that here, as well as in several other parts of this work, the author makes an ingenious attack against the existence and utility of final causes. Every philosopher will admit the absurdity of employing a final cause as a physical principle. M. de Buffon, if he meant only to expose the misapplication of final causes, had no occasion to betray so much warmth and anxiety about an object so apparent. But, like too many of our modern French writers, he seems to neglect the distinction between final and physical causes. Final causes regard the design or the utility of particular objects, whether that utility relates to man, to the objects themselves, or to the general structure of the universe. But physical causes are limited to the explanation of particular effects, or modes of existence. *Why* were mountains, seas, or insects, created? *What* useful purposes do they serve? For the solution of these, and similar questions, final causes can alone be employed. But if it be asked, *How* were mountains and seas formed? *How* were insects originally produced; and *how* are their different species propagated? These are questions purely physical.

It may be farther remarked, that final causes are the greatest stumbling-blocks which lie in the way of atheists and materialists.

They

Much more might be ſaid upon this ſubject. But I pretend not to write a treatiſe on philoſophy; and ſhall therefore return to phyſics, from which the ideas of Plato, concerning univerſal generation, have diverted my attention. Ariſtotle, who was as great a philoſopher as Plato, and a better phyſician, inſtead of wandering in the regions of theory, collects facts, and ſpeaks in a language more intelligible.

Matter, he remarks, which is only a capacity of receiving forms, aſſumes, in generation, à figure ſimilar to the individual which furniſhes it: And, with regard to animals which generate by the intervention of ſexes, he imagines, that the prolific principle proceeds ſolely from the male *: For though, in another place, when ſpeaking of animals in general, he ſays, that the female ſheds

They, accordingly, ſtrain every nerve to remove them. But their force is ſo irreſiſtible; their numbers are ſo immenſe; their beauties are ſo ſtriking, and correſpond ſo intimately with the warm and benevolent feelings of the heart; the concatenation and mutual dependence of all created beings recogniſable by our ſenſes are ſo apparent, and ſo illuſtrious, that no powers of ſophiſtry, no artful miſrepreſentations, no ſtrokes of ridicule, will ever be able to diminiſh their influence, or weaken the force of thoſe ſentiments which the Supreme Being intended they ſhould excite in the breaſts of his intelligent creatures. Final cauſes not only demonſtrate the exiſtence of a Supreme Intelligent Power, but the infinite beneficence, and minute attention of that power to the happineſs of thoſe beings upon whom He has thought proper to confer exiſtence.

* See Ariſtot. de Gen. lib. 1. cap. 20. and lib. 2. cap. 4.

ſheds a ſeminal fluid within the body, it appears, that he regards not this fluid as a prolific principle; and yet he tells us, that the menſtrual blood ſerves for the formation, nouriſhment, and growth of the foetus; but that the efficient principle exiſts alone in the ſeminal fluid of the male, which acts not as matter, but as a cauſe. Averrhoes, Avicenna, and other philoſophers who embraced this opinion of Ariſtotle, have endeavoured to prove that females have no prolific fluid. They alledge, that, as females are furniſhed with a menſtrual fluid, which is both neceſſary and ſufficient for the purpoſes of generation, it is unnatural to ſuppoſe them poſſeſſed of any other, eſpecially ſince it begins to appear, like that of the male, at the age of puberty. Beſides, they continue, if females really have a prolific ſeminal fluid, why do they not produce without the intercourſe of the male, ſince they contain the prolific principle, as well as the matter neceſſary for the growth and expanſion of the embryo? This laſt reaſon is the only one which merits attention. The menſtrual blood appears to be neceſſary for the growth and nouriſhment of the foetus; but ſtill it may contribute nothing to its firſt formation, which requires the mixture of both prolific fluids. Females, therefore, like males, may have a prolific fluid for the formation of the embryo, as well as menſtrual blood for its growth and nouriſhment. The imagination is not unnatu-

ral,

ral, that, as the female poſſeſſes both a prolific fluid extracted from all parts of her body, and likewiſe the means of expanding and nouriſhing, ſhe ſhould produce females without any communication with the male. It muſt be allowed, that this metaphyſical argument uſed by the Ariſtotelians for proving that females are deſtitute of a prolific fluid, may be urged as the ſtrongeſt argument againſt every ſyſtem of generation, and, in particular, againſt that which I am endeavouring to eſtabliſh.

Let us ſuppoſe, it may be ſaid, that the ſuperfluous organic particles are ſent from every part of the body into the teſticles and ſeminal veſſels of the male, why do they not, by means of your imaginary attracting forces, form ſmall organized bodies ſimilar to the whole? Why are not ſimilar bodies generated in the female, without any intercourſe with the male? If you anſwer, that the male fluid contains only males, that the female fluid contains only females, that both periſh for want of the circumſtances neceſſary for expanſion, and that, for the procreation of an animal, a mixture of both is requiſite; may it not be demanded, why this moſt complicated, difficult, and leſs fertile mode of generation, is ſo invariably preferred by Nature, that all animals, with a few trifling exceptions, generate by the mutual commerce of ſexes?

I ſhall content myſelf, at preſent, with replying, that this is the mode actually employed by

Nature;

Nature; and, therefore, however complicated it may appear, it is, in fact, the most simple; because, as I formerly remarked, whatever most frequently happens is, in itself, however it may seem to us, the most simple.

Besides, the notion of the Aristotelians, that females have no seminal fluid, cannot receive our assent, if we consider the strong resemblance of children to their mothers, and that mules, mulattoes, and mongrels of every kind, uniformly resemble the mother more than the father; and, if it be farther considered, that the generating organs of the female, like those of the male, are properly formed for preparing and receiving a seminal fluid, we shall be easily induced to believe the existence of such a fluid, whether it resides in the spermatic vessels, the testicles, or the ovaria, or proceeds, by irritation, from the lacunae of De Graaf, which are situated at the neck and near the orifice of the uterus.

But we must examine Aristotle's ideas more fully, as, of all the ancients, this great philosopher has treated the subject of generation in the most extensive manner. He distinguishes animals into three classes: 1. Those that have blood, and, with few exceptions, propagate by copulation; 2. Those that have no blood, and, being hermaphrodites, produce of themselves without copulation; and, 3. Those that proceed from putrefaction, and have no parents of any kind. I shall first remark, that this division is exceedingly

ingly improper: Though it be true, that animals having blood are diſtinguiſhed into male and female, it is by no means equally true, that bloodleſs animals are, for the moſt part, hermaphrodites: For the only hermaphrodites we know, are land-ſnails and worms; but we are uncertain whether all ſhell-animals, and all thoſe which have no blood, be alſo hermaphrodites. This muſt be learned from the particular hiſtories of theſe animals. And, with regard to thoſe which are alledged to proceed from putrefaction, as Ariſtotle gives no enumeration of them, many objections occur; for moſt ſpecies which the ancients believed to proceed from putrefaction, have, by the moderns, been diſcovered to proceed from eggs.

Ariſtotle makes a ſecond diviſion of animals, namely, into thoſe which have the faculty of progreſſive motion, and thoſe which have no ſuch faculty. All animals who move, and have blood, are diſtinguiſhed by ſexes: But thoſe which, like oyſters, adhere to one place, or hardly move at all, have no ſexes, and, in this reſpect, reſemble plants; and it is only, he obſerves, from difference in bulk that they have been diſtinguiſhed into male and female. It muſt be acknowledged, that we are ſtill uncertain whether ſhell-animals have ſexes: Among oyſters, ſome individuals are fertile, and others not. The fertile individuals are diſtinguiſhed by a delicate edging or border which ſurround their bodies, and

and they are called males *. Our obſervations on this ſubject are extremely limited.

But to proceed. The male, according to Ariſtotle, contains the principle of motion, and the female the material part of generation. The organs deſtined for this purpoſe are different in different animals. Of theſe the teſticles are the chief in males, and the uterus in females. Quadrupeds, birds, and cetaceous animals, have teſticles ; fiſhes and ſerpents are deprived of them ; but they have two canals for the reception and maturation of the ſemen : Theſe parts, ſo eſſential to generation, are always double both in males and females ; and, in the male, they retard the motion of that part of the blood which goes to the formation of ſemen. This he proves from the example of birds whoſe teſticles ſwell conſiderably during the ſeaſon of their amours, but afterwards diminiſh ſo much, that they can hardly be diſcovered.

All quadrupeds covered with hair, and the cetaceous fiſhes, as whales and dolphins, are viviparous : But vipers and cartilaginous animals are not properly viviparous ; becauſe they produce an egg within their own bodies, previous to the excluſion of the live animal. Oviparous animals are of two kinds ; thoſe which produce perfect eggs, as birds, lizards, turtles, &c. and thoſe which produce imperfect eggs, as fiſhes, whoſe eggs augment and come to perfection

* See Deſlandes dans ſon traité de la marine. Paris 1747.

tion after they have been depoſited in the water by the female: And, in every ſpecies of oviparous animals, except birds, the females are larger than the males, as in fiſhes, lizards, &c.

After remarking theſe general varieties in the animal kingdom, Ariſtotle begins with examining the opinion of the ancient philoſophers, that the ſemen, both of the male and female, was extracted from all parts of the body; and he diſſents from this opinion; becauſe, ſays he, though children often reſemble both father and mother, they ſometimes alſo reſemble their grandfathers. Beſides, they reſemble their fathers and mothers in the voice, in the hair, in the nails, and in the gate and manner of walking. Now, he proceeds, it is impoſſible for the ſemen to come from the hair, from the voice, from the nails, or from any external quality, as that of the mode of walking. Infants, therefore, reſemble not their parents becauſe the ſemen proceeds from all parts of the body, but for other reaſons. I will not expoſe the weakneſs of theſe arguments; but ſhall only remark that this great man appears to have been anxious to differ from the ſentiments of former philoſophers: And I am perſuaded, that, whoever peruſes his treatiſe on generation, will diſcover that a ſtrong paſſion for eſtabliſhing a ſyſtem different from that of the ancients, obliges him uniformly to prefer arguments of little probability, to the force

force of proofs, when they ſtand in oppoſition to the general principles of his philoſophy.

The ſeminal liquor of the male, according to Ariſtotle, is ſecreted from the blood; and the menſtrual fluid of the female is likewiſe a ſecretion from the blood, and the only matter which contributes to generation. Females, he continues, have no other prolific fluid; no mixture, therefore, of male and female fluid takes place: This notion he attempts to prove by obſerving, that ſome women conceive without pleaſure; that few emit any fluid during the time of copulation; that, in general, thoſe who are brown, and have a maſculine air, have no emiſſion; and yet their powers of procreation are not leſs than thoſe of a fairer complexion and more delicate appearance, who emit copiouſly. Thus, he concludes, women furniſh nothing for the purpoſes of generation, but the menſtrual blood. This blood is the matter of generation, and the male fluid contributes nothing but the form: The male fluid is the efficient cauſe, and the principle of motion; it is to generation what the ſculptor is to a block of marble: The ſeminal fluid is the ſculptor, the menſtrual blood the marble, and the foetus the figure. The menſtrual blood receives from the male ſemen a kind of ſoul, which gives it life and motion. This ſoul is neither material nor immaterial, becauſe it can neither act upon matter, nor augment the menſtrual blood, which is the only matter neceſ-

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ſary to generation. It is a ſpirit, ſays our philoſopher, ſimilar to that of the element of the ſtars. The heart is the firſt production of this ſoul, which is the cauſe of its own growth, and of the growth and diſpoſition of all the other members. The menſtrual blood contains the *capacities* of all the parts of the foetus; the ſoul or ſpirit of the male ſemen makes the heart begin to *act*, and communicates to it the powers of beſtowing *action* on the other viſcera; and, in this manner the different parts of the animal are ſucceſſively unfolded. All this appears clear and luminous to our philoſopher. He has only one doubt, namely, whether the blood or the heart is firſt realized. And of this he doubted not without reaſon; for, though he adopted the opinion that the heart received its exiſtence firſt, Harvey has ſince alledged, from arguments ſimilar to thoſe of Ariſtotle, that the blood, and not the heart, is firſt realized.

Thus have I given a ſhort view of what Ariſtotle has delivered on the ſubject of generation, and ſhall leave the reader to conſider whether any ſyſtem of the ancients be more obſcure, or more abſurd, than that which he has endeavoured to eſtabliſh. His ſyſtem, however, has been adopted by moſt men of learning. Harvey has borrowed many of Ariſtotle's notions; but he has alſo adopted ſome of his own, which are by no means better founded. It is not ſurpriſing that Ariſtotle's theory of generation, which

which was a reſult of his ſyſtem of philoſophy, where form and matter are the great principles, where vegetable and ſenſitive ſouls are the agents of Nature, and where final cauſes are real objects, ſhould have been received in the ſchools: But it is not a little aſtoniſhing to ſee a phyſician and an acute obſerver, like Harvey, carried down the ſtream, while, at the ſame time, moſt philoſophers followed the ſentiments of Hippocrates and Galen, of which we ſhall afterwards take notice.

We mean not to convey a diſadvantageous idea of Ariſtotle by the account we have given of his theory of generation. We might with equal propriety judge of Deſcartes by his treatiſe on man. What theſe two philoſophers have remarked concerning the formation of the foetus ſhould rather be conſidered in the light of detached obſervations, or as conſequences which each of them drew from their principles of philoſophy, than as complete ſyſtems. Ariſtotle admits, with Plato, final and efficient cauſes: The latter are the ſenſitive and vegetable ſouls, that give form to matter, which, in itſelf, is only a *capacity* of receiving forms: And as, in generation, the female furniſhes the greateſt quantity of matter, and as it was repugnant to his ſyſtem of final cauſes, that any effect ſhould be produced by two cauſes, when one was ſufficient for the purpoſe, he concludes, that the woman alone contains the matter neceſſary for procreation:

tion: Again, another of his principles is, that matter, in itſelf, has no form, and that *form* is a being diſtinct from matter; he therefore maintains, that the male furniſhes the form, and, of courſe, that he contributes nothing *material.*

Deſcartes, on the contrary, admitted into his philoſophy a few mechanical principles only. By theſe he attempted to explain the formation of the foetus; and he imagined that he underſtood, and was able to communicate to others, the manner in which a living organized body could be formed by the laws of motion alone. The principles he employed were different from thoſe of Ariſtotle. But both of them, inſtead of directing their inquiries to the ſubject itſelf, in place of examining it with impartiality, conſidered it only in relation to their philoſophic principles, which could never be applied with ſucceſs to the nature of generation, becauſe it depends, as has been already ſhown, upon very different principles. Deſcartes, however, admits the exiſtence and neceſſary concurrence of the ſeminal fluids of both ſexes. He allows that both furniſh ſomething material for the purpoſes of generation; and that the fermentation occaſioned by a mixture of the two fluids, is the cauſe of the formation of the foetus.

Hippocrates, who lived about five or ſix hundred years before Ariſtotle, taught an opinion, which was adopted by Galen, and by moſt phyſicians, for many ages. He maintained the exiſtence of a female fluid; and even that both male and female had two fluids, the one ſtrong and active, the other weaker and more ſluggiſh *. A concurrence of the two ſtronger fluids produced a male child, and, of the two weaker, a female. Thus, according to Hippocrates, there exiſt two kinds of ſeminal fluids both in the male and in the female. This notion he ſupports in the following manner: Several women who produced girls only by their firſt huſband, have had boys by their ſecond; and the ſame thing has often happened to men who have had two wives. Suppoſing this to be fact, it admits of an eaſy explanation, without having recourſe to two different fluids peculiar to each ſex; for the women who had girls only by the firſt huſband, and boys by the ſecond, furniſhed a greater quantity of particles proper for generation during the firſt, than the ſecond marriage; or the ſecond huſband furniſhed a greater quantity of generating particles during the time of the ſecond marriage, than the firſt. If, at the moment of conception, the organic particles of the male are more abundant than thoſe of the female, a male child is the reſult; and, when the organic particles of the female moſt abound, a female child is the conſequence: It is not, therefore, ſurpriſing, that the huſband ſhould be foiled with ſome women, and have the ſuperiority over others.

It

* See Hippocrat. lib. de Genitura, p. 129. et lib. de Diaeta, p. 198. Lugd. Bat. tom. 1. 1665.

It is farther alledged by Hippocrates, that the male ſemen is ſecreted from the ſtrongeſt and moſt eſſential fluids of the body; and he thus explains the manner in which the ſecretion is performed: 'Venae et nervi,' ſays he,' ab omni corpore in pudendum vergunt, quibus dum aliquantulum teruntur, et caleſcunt ac implentur, velut pruritus incidit, ex hoc toti corpori voluptas ac caliditas accidit; quum vero pudendum teritur et homo movetur, humidum in corpore caleſcit ac diffunditur, et a motu conquaſſatur ac ſpumeſcit, quemadmodum alii humores omnes conquaſſati ſpumeſcunt.

'Sic autem in homine ab humido ſpumeſcente id quod robuſtiſſimum eſt ac pinguiſſimum ſecernitur, et ad medullam ſpinalem venit; tendunt enim in hanc ex omni corpore viae, et diffundunt ex cerebro in lumbos ac in totum corpus et in medullam: Et ex ipſa medulla procedunt viae, ut et ad ipſam humidum perferatur et ex ipſa ſecedat; poſtquam autem ad hanc medullam genitura pervenerit, procedit ad renes, ac enim via tendit per venas; et ſi renes fuerint exulcerati, aliquando etiam ſanguis defertur: A renibus autem tranſit per medios teſtes in pudendum, procedit autem non qua urina, verum alia ipſi via eſt illi contigua*,' &c.

It will, doubtleſs, be perceived by anatomiſts, that Hippocrates errs in tracing the route of the ſeminal fluid. But this error effects not his hypotheſis,

* See Feſius's tranſlations, tom. I. p. 129.

pothesis, that the semen proceeds from every part of the body, and particularly from the head; because he remarks, those who have had the veins behind their ears cut, secrete only a weak and often an unfertile semen. The female likewise sheds a seminal fluid sometimes within the uterus, and sometimes without it, when the orifice is too open. The male semen enters the uterus and mixes with that of the female; and as each has two species of fluid, the one strong and the other weak, if both of them furnish the strong kind, a male foetus is the consequence; and, if both furnish the weak kind only, the result is a female: Besides, if in the mixture there are more particles of the male than of the female fluid, the child will resemble the father more than the mother; *et e contrà*. Here we might ask him, what would happen, when the fluid of the one was strong and that of the other weak? I cannot conceive what reply could be made to this question; and, therefore, we are warranted to reject the opinion of two distinct fluids in each sex as perfectly chimerical.

Let us now attend to his account of the formation of the foetus. The seminal fluids first mix in the uterus, and gradually thicken by the heat of the mother. The mixture extracts the spirit of heat, and, when too warm, part of the heat escapes into the air. But a cold spirit is likewise conveyed to it by the respiration of the mother: Thus a cold and a hot spirit alternately

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enter the mixture, give life to it, and cover its ſurface with a pellicle, which aſſumes a round figure, becauſe the ſpirits acting in the centre, expand the matter equally on all ſides. I have ſeen, ſays this great phyſician, a foetus of ſix days old: It was a ball of liquor incloſed in a pellicle. The liquor was reddiſh; and the pellicle was interſperſed with red and colourleſs veſſels. In the middle of it there was a ſmall eminence, which I apprehended to be the umbilical veſſels, by which the foetus receives nouriſhment and the ſpirit of reſpiration from the mother. A ſecond covering or pellicle gradually forms above the firſt. Abundance of nouriſhment is furniſhed by the menſtrual blood, which coagulates by degrees, and is converted into fleſh. This fleſh gradually articulates as it grows; and the ſpirit beſtows upon it this form. Every part aſſumes its proper place; the ſolid particles unite; the moiſt particles aſſociate by themſelves; every thing ſearches for what is analogous to it; and, in fine, the foetus, by theſe cauſes and means, is completely formed.

This ſyſtem is more rational, and leſs obſcure than that of Ariſtotle; becauſe Hippocrates endeavours to explain every particular appearance, and borrows one general principle only from the philoſophy of his times, namely, that heat and cold produce ſpirits, and that theſe ſpirits have the power of arranging and of beſtowing figure upon matter. He treats his ſubject more like a phyſician than a philoſopher; but Ariſtotle explains the phaenomena of generation more as a metaphyſician than a naturaliſt. It is for this reaſon that the errors of Hippocrates are particular and leſs apparent, and that thoſe of Ariſtotle are general and evident.

Theſe two great men have each had their followers. Almoſt all the philoſophers of the ſchools adopted Ariſtotle's theory of generation, while moſt phyſicians adhered to the theory of Hippocrates; and, in this manner, 17 or 18 centuries paſſed without the appearance of any thing new upon this myſterious ſubject.

At laſt, upon the revival of literature, ſome anatomiſts began to inveſtigate the nature of generation; and Fabricius ab Aquapendente was the firſt who thought of making a courſe of experiments upon the impregnation and expanſion of the eggs of fowls, the ſubſtance of which we ſhall lay before the reader.

He diſtinguiſhes the matrix of a hen into two parts, the one ſuperior, and the other inferior. The ſuperior part, which he calls the ovarium, is an aſſemblage of a great number of ſmall yellow eggs, of a round figure, the ſizes of which vary from that of a muſtard ſeed to that of a walnut. Theſe eggs are attached to one another by foot-ſtalks, and the whole ſomewhat reſembles a bunch of grapes. The ſmalleſt eggs

eggs are white, and they turn yellower in proportion as they increaſe.

Having examined thoſe yellow eggs immediately after a communication with the male, he could perceive no ſenſible difference; he ſaw none of the male ſemen in any part of the eggs: He therefore concluded, that the whole eggs, and even the ovarium itſelf, were rendered fertile by a ſubtile ſpirit which iſſues from the male ſemen; and, he adds, that, in order to prevent the eſcape of this fecundating ſpirit, Nature has placed, at the external orifice of the vagina of birds, a membranous valve which permits the ſeminal ſpirit to enter freely into the vagina, but prevents its return.

When an egg is detached from the common pedicle, it gradually deſcends, through a winding canal, into an inferior part of the matrix. This canal is filled with a liquor very ſimilar to the white of an egg. It is here that the egg receives its white liquor, the membrane in which it is incloſed, the two cords (*chalazae*) that run through the white, and join it to the yolk, and the ſhell which is ſuddenly formed immediately before excluſion. Theſe cords, according to our author, are the part of the egg which is impregnated by the ſeminal ſpirit of the male; and it is here alſo that the rudiments of the foetus firſt appear. The egg is not only the true matrix, or the place where the chick is formed, but the whole buſineſs of generation depends upon it.

it. The egg is the great agent in generation; it furniſhes both the matter and the organs. The ſubſtance of the cords is the matter of which the chick is formed; the white and the yolk afford it nouriſhment; and the ſeminal ſpirit of the male is the efficient cauſe. This ſpirit communicates to the cords, firſt, an alterant quality, then a forming quality, and, laſtly, a power of augmenting, &c.

Theſe obſervations of Fabricius, it is apparent, lead not to any clear idea of generation. At the ſame time that this anatomiſt was making his experiments, which was about the middle of the ſixteenth century, the famous Aldrovandus* made ſome remarks upon eggs. But, as Harvey properly obſerves of him, he followed more the authority of Ariſtotle than of experiment. The deſcription he gives of the chick in the egg is by no means exact. Volcher Coiter, one of his pupils, ſucceeded better than his maſter; this writer, together with Pariſanus, a Venetian phyſician, have each given deſcriptions of the chick in the egg, which Harvey prefers to all the others.

This celebrated anatomiſt, who firſt diſcovered the circulation of the blood, has given an excellent treatiſe on generation. He flouriſhed about the middle of laſt century, and was phyſician to Charles I. of England. As he was obliged to follow this unhappy Prince during his misfortunes,

* See his Ornithologia.

misfortunes, he loſt, among other papers, what he had written concerning the generation of inſects; and it appears, that he compoſed from memory his treatiſe on the generation of birds, and of quadrupeds. I ſhall give a ſhort view of his remarks, of his experiments, and of his theory.

Harvey alledges, that men, and all other animals, proceed from eggs; that, in viviparous animals, the firſt produce of conception is a kind of egg; and that the only difference between the viviparous and oviparous is, that, in the former, the foetuſes begin to exiſt, increaſe, and acquire their full growth in the uterus; but that, in the oviparous animals, the rudiments of the foetuſes begin to exiſt in the body of the mother, where they are in the form of eggs; and it is only after their excluſion that they become real foetuſes. And it deſerves to be remarked, ſays he, that, in oviparous animals, ſome retain their eggs till they be perfect, as birds, ſerpents, and oviparous quadrupeds; and that others exclude their eggs before they are perfect, as fiſhes, cruſtaceous and teſtaceous animals. The eggs laid by theſe creatures are only the rudiments of eggs, which afterwards acquire membranes and a white, and attract nouriſhment from the matter with which they are ſurrounded. There are even, he adds, inſects, caterpillars, for example, which are only imperfect eggs; they ſearch for their nouriſhment, and, at the end of a certain time,

they

they arrive at the ſtate of a chryſalis, which is a perfect egg. Another difference may ſtill be remarked in oviparous animals: The eggs of hens, and other birds, are of all different ſizes; but thoſe of fiſhes, frogs, &c. which lay them before they are perfect, are all of the ſame ſize. He indeed obſerves, that, in pigeons, which lay two eggs, all the ſmall eggs that remain in the ovarium are of the ſame bulk; and that the two only which are next to be excluded exceed the ſize of the reſt. The ſame thing happens in cartilaginous fiſhes, as in the ray, which only brings to maturity two eggs at a time, all the reſt being of different ſizes, like thoſe of the hen.

He next deſcribes anatomically the parts neceſſary to generation; and remarks, that the ſituation of the anus and vulva in birds differ from thoſe of all other animals, the anus being placed before, and the vulva behind *. And, with regard to the cock and all ſmall birds, he alledges, that they have no proper penis, and that they generate by rubbing, without any intromiſſion. But male-ducks, geeſe, and oſtriches, are amply provided with this inſtrument.

Hens produce eggs without the intervention of the cock; but, though perfect, they are fewer in number, and unfertile. He credits not the common opinion, that a few days intercourſe with the cock are ſufficient to impregnate all the eggs which a hen will lay during the year; but

* Moſt of theſe facts are taken from Ariſtotle.

but he acknowledges, that he ſeparated a hen from the cock for 20 days, and that all the eggs ſhe laid were fecundated. As long as the egg remains attached to the ovarium, it is nouriſhed by the veſſels of the common pedicle; but, when it ſeparates from this pedicle, it receives the white liquor and the ſhell from the matter with which the canal of the uterus is filled.

The two cords (*chalazae*) which Aquapendente conſidered to be the germ, or part produced by the male ſemen, are found in unimpregnated, as well as impregnated eggs; and Harvey properly obſerves, that theſe parts neither proceed from the male, nor receive the impregnation. The part of the egg which receives the impregnation is a ſmall white circle ſituated upon the membrane that covers the yolk, and has the appearance of a cicatrice about the ſize of a lentil. Harvey likewiſe remarks, that this cicatrice is found in all eggs, whether they be fecundated or not; and that thoſe are deceived who imagine it to be produced by the ſeed of the male. It is of the ſame ſize and form in freſh eggs as in thoſe which have been long kept. But, as ſoon as the proceſs of hatching is begun, whether by means of artificial heat, or by the heat of the hen, this ſmall mark or cicatrice gradually augments and dilates like the pupil of the eye. This is the firſt change, and it is viſible after a few hours incubation.

When the egg has been heated for 24 hours, the yolk, which was formerly in the centre, riſes towards the cavity at the thick end of the egg. This cavity continues to enlarge by the evaporation of the more fluid part of the white; and the heavieſt part of the white falls down to the ſmall end. The cicatrice or ſpeck on the membrane of the yolk, is elevated along with it, and applies itſelf to the membrane which lines the cavity at the thick end. This ſpeck is now as large as a pea; and a white point is diſtinguiſhable in the middle of it, with ſeveral circles, of which this point appears to be the common centre.

At the end of the ſecond day, theſe circles are larger and more conſpicuous, and they divide the ſpeck ſometimes into two, and ſometimes into three parts, of different colours. A ſmall external protuberance likewiſe appears, which nearly reſembles a little eye, with a white point or cataract on the pupil. Between the circles, a liquor, as tranſparent as cryſtal, is contained by means of a very thin membrane. The ſpeck, which is now become a kind of bubble, or liquid globe, appears as if it were ſituated in the white, rather than on the membrane of the yolk. On the third day the tranſparent liquor, as well as the membrane in which it is incloſed, is conſiderably augmented. On the 4th, a ſmall line of blood, of a purple colour, appears on the circumference of the bubble; and, at a little diſtance from the centre, we perceive a dot or point, of a bloody colour,

colour, which beats like a heart. It is viſible at every diaſtole, and diſappears during the ſyſtole. From this animated point two ſmall blood-veſſels iſſue, and terminate in the membrane which contains the tranſparent cryſtalline liquor. Theſe blood-veſſels ſet off from the ſame place, nearly in the ſame manner as the roots of a tree ſet off from the trunk; and it is in the angle which theſe roots form with the trunk, and in the middle of the liquor, that the animated point is ſituated.

Towards the end of the fourth, or beginning of the fifth day, the animated point is ſo much enlarged, that it has the appearance of a ſmall bladder filled with blood; and, by its contractions and dilatations, it is alternately filled and emptied. On the ſame day we diſtinctly perceive, that this bladder is divided into two parts, each of which dilates and contracts in the ſame manner. Round the ſhorteſt of the blood-veſſels deſcribed above, a kind of cloud appears, which, though tranſparent, obſcures the view of the veſſel. Every hour this cloud becomes thicker; it attaches itſelf to the root of the blood-veſſel, and ſeems to depend from it like a ſmall globe. This globe extends, and appears to divide into three parts, one of which is globular, and larger than the other two; and here we perceive the rudiments of two eyes, and of the whole head: And, at the end of the fifth day, we ſee, in the remainder of this lengthened globe, the beginnings of the vertebrae.

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On the ſixth day, the parts of the head are more apparent. We diſtinguiſh the coats of the eyes, the thighs, and wings; and then the liver, the lungs, and the beak. The foetus now begins to move and to ſtretch out its head, though nothing but the viſcera are yet formed; for the thorax, the abdomen, and all the external coverings of the fore part of the body, are ſtill wanting. At the end of this day, or the beginning of the ſeventh, the claws begin to be viſible; the chick opens and moves its beak; and the anterior parts of the body begin to cover the viſcera. On the ſeventh day, the chick is entirely formed; and, from this time till it iſſues from the egg, nothing happens but an expanſion of all the parts it acquired during the firſt ſeven days. The feathers appear on the 14th or 15th day; and, on the 21ſt, the chick eſcapes from the egg, by breaking the ſhell with its bill.

Theſe experiments of Harvey appear to have been made with the greateſt exactneſs and fidelity. We ſhall afterwards, however, demonſtrate their imperfection, and that the author has probably fallen into the common error of making experiments, with a view to eſtabliſh his favourite hypotheſis, that the firſt animated point which appeared was the heart. But, before proceeding to this object, it is proper to give an account of his other experiments.

Every body knows the numerous experiments made by Harvey upon female deer. They receive the

the male about the middle of September. A few days after copulation, the *horns* * of the uterus appear to be thicker and more fleſhy than uſual: They are, at the ſame time, more lax and flabby; and, in each of their cavities, five carunculae, or ſoft warts, appear. About the 26th or 28th of September, the uterus is ſtill thicker; the five carunculae are ſwelled nearly to the ſize and form of a nurſe's nipple. On opening them with a ſcalpel, they appeared to be filled with an infinite number of white points. Harvey pretends to have remarked, that, neither now, nor immediately after copulation, had the ovarium ſuffered any change; and that he never could diſcover, after repeated trials, the leaſt drop of male ſemen in the uterus.

Towards the end of October, or the beginning of November, when the females were ſeparated from the males, the thickneſs of the *horns* began to diminiſh; the internal ſurfaces of their cavities were ſwelled, and ſeemed to be glued together. The carunculae ſtill remained; and the whole reſembled the ſubſtance of the brain, being ſo ſoft that it could not be touched. Harvey tells us, that, on the 13th or 14th of November, he perceived filaments, like thoſe of a ſpider's web, which traverſed the cavities of the *horns*, and even that of the uterus itſelf. Theſe filaments aroſe from the ſuperior angle of the *horns*,

* Two fleſhy proceſſes, one of which iſſues from each ſide of the *fundus uteri*, in the form of little *horns*, and are remarkably large in ſome quadrupeds.

horns, and, by their number, formed a kind of membrane or empty coat. A day or two afterwards, this coat or ſac was filled with a white, aqueous, viſcid matter, and adhered to the uterus by means of a kind of mucilage; and the adheſion was moſt ſenſible at the ſuperior part of the uterus, where the rudiments of the placenta began then to appear. In the third month, this ſac contained an embryo of two fingers breadth in length, and alſo an internal ſac, called the amnios, incloſing a tranſparent cryſtalline liquor, in which the foetus ſwam. The foetus, at firſt, was only an animated point, like what appeared in the hen's egg. Every thing now proceeded and terminated in the ſame manner as deſcribed with regard to the chick, with this only difference, that the eyes of the chick appeared much ſooner than thoſe of the deer. The animated point was viſible about the 19th or 20th of November. A day or two afterwards, the oblong body, which contained the rudiments of the foetus, made its appearance. In ſix or ſeven days more, the foetus was ſo completely formed, that all its members, and even its ſex, were diſtinguiſhable. But the heart and viſcera were ſtill bare; and it was not till a day or two after, that they were covered with the integuments of the abdomen and thorax. This is the laſt work, the ſlating of the edifice.

From theſe experiments upon hens and deer, Harvey concludes, that all female animals have

eggs;

eggs; that in theſe eggs a ſeparation of a tranſparent cryſtalline liquor, contained in a ſac (*amnios*) takes place, and that another external ſac (*chorion*) incloſes the whole liquors of the egg; that the firſt thing which appears in the cryſtalline liquor is an animated ſanguineous point; and, finally, that the formation of viviparous animals is effected in the ſame manner as that of the oviparous: The following is the account which he gives of the generation of both.

Generation, he obſerves, is an operation of the uterus alone; for not a drop of the male ſemen ever enters it. The uterus conceives by a kind of contagion, communicated to it by the ſemen of the male nearly in the ſame manner as the load-ſtone communicates a magnetic virtue to iron. This male contagion acts not only on the uterus, but on the whole body of the female, which is entirely fecundated, though the uterus alone poſſeſſes the faculty of conception, in the ſame manner as the brain has the ſole power of conceiving ideas. The ideas conceived by the brain are ſimilar to the images of the objects tranſmitted to it by the ſenſes; and the foetus, which may be regarded as the idea of the uterus, is ſimilar to that by which it is produced. This is the reaſon why children reſemble their fathers, &c.

I will follow the ſyſtem of our anatomiſt no farther: What has been ſaid is ſufficient to enable the reader to form a judgment. But we have remarks of importance to make concerning his

 experiments,

experiments. He has reprefented them in a manner the moft plaufible and infinuating. He appears to have repeated them often, and to have taken every neceffary precaution to avoid fallacy and deception; and of courfe we are led to think that he has feen every thing which poffibly could be difcovered. Uncertainty and obfcurity, however, are perceptible in his defcriptions. His obfervations are related from memory; and he feems, though he often maintains the contrary, to have made Ariftotle, more than experience, his guide; for he has feen every thing in eggs, and very little more than was mentioned by that philofopher. That the moft material of his obfervations were made long before his own time, we fhall be convinced by attending to what follows.

Ariftotle knew, that the cords (*chalazae*) in eggs were of no ufe in the generation of the chick: 'Quae ad principium lutei grandines 'haerent, nil conferunt ad generationem, ut qui-'dam fufpicantur *.' Parifanus, Volcher Coiter, Aquapendente, &c. had remarked the fmall cicatrice, as well as Harvey. Aquapendente believed it to be of no ufe; but Parifanus maintained that it was formed by the male femen, or, at leaft, that the white point in the middle of the cicatrice was the femen of the male, and that it was the rudiments of the foetus. 'Eftque,' fays he, 'illud galli femen alba et tenuiffima tu-'nica

* Hift. Anim. lib. 6. cap. 2.

'nica abductum, quod ſubſtat duabus communi-'bus toti ovo membranis,' &c. Hence the only diſcovery proper to Harvey conſiſts in his remarking the exiſtence of this cicatrice, both in fecundated and unfecundated eggs; for the other writers had obſerved, as well as he, the dilatation of the circles, and the growth of the white point. Theſe are all the remarks Harvey has made in his account of the two firſt days of incubation; what he mentions concerning the third day is a repetition only of what Ariſtotle delivers in the ſixth book and fourth chapter of his hiſtory of animals: 'Per id tempus aſcendit 'jam vitellus ad ſuperiorem partem ovi acutio-'rem, ubi et principium ovi eſt et foetus exclu-'ditur; corque ipſum apparet in albumine ſan-'guinei puncti, quod punctum ſalit et movet ſe-'ſe inſtar quaſi animatum; ab eo meatus vena-'rum ſpecie duo, ſanguine pleni, flexuoſi, qui, 'creſcente foetu, feruntur in utramque tunicam 'ambientem, ac membrana ſanguineas fibras ha-'bens eo tempore albumen continet ſub meati-'bus illis venarum ſimilibus; ac paulo poſt diſ-'cernitur corpus puſillum initio, omnino et can-'didum, capite conſpicuo, atque in eo oculis 'maxime turgidis qui diu ſic permanent, ſero e-'nim parvi fiunt ac conſidunt. In parte autem 'corporis inferiore nullum extat membrum per 'initia, quod reſpondeat ſuperioribus. Meatus 'autem illi qui a corde prodeunt, alter ad cir-

'cumdantem membranam tendit, alter ad lute-
'um, officio umbilici.'

Harvey, becauſe Ariſtotle ſays that the yolk riſes to the ſmall end of the egg, concludes that he had ſeen nothing himſelf, but that he had received his information from ſome other pretty accurate obſerver. In this accuſation, Harvey evidently injures Ariſtotle; for the riſing of the yolk to either end, depends ſolely upon its poſition during the time of incubation; for the yolk, being lighter than the white, uniformly mounts to the top, whether the large or the ſmall end of the egg be uppermoſt. This obſervation we owe to William Langley, a phyſician in Dordrecht, who made experiments on the hatching of eggs in the year 1655, about 20 years before Harvey's time *.

But, to return to the paſſage we have quoted. It is apparent, that the cryſtalline liquor, the animated point, the two circles, the two blood-veſſels, &c. are deſcribed by Ariſtotle in the ſame manner as they were ſeen by Harvey. This anatomiſt maintains, that the animated point is the heart, that the heart is the firſt part of the foetus which is formed, and that the viſcera and other members ſucceed. All theſe circumſtances have been mentioned by Ariſtotle, and ſeen by Harvey; and yet that the heart is firſt formed is by no means conſonant to truth. To be aſſured of this fact, we have only to repeat the ſame experiments,

* See Langley obſerv. editae a Juſto Schradero, Amſt. 1674.

periments, or to read with attention thoſe of Malpighius *, which were made about 50 years after the trials of Harvey.

Malpighius carefully examined the cicatrice, which is the eſſential part of the egg; he found that it was large in impregnated eggs, and ſmall in thoſe which had received no impregnation; and he diſcovered, that, in eggs which had never been ſat upon by the hen, the white point, mentioned by Harvey as the firſt part that becomes animated, is a ſmall purſe or bubble ſwimming in the liquor bounded by the firſt circle; and that the embryo is viſible in the centre of this purſe. The membrane of the purſe, which is the amnios, being exceedingly thin and tranſparent, allowed him to ſee the foetus diſtinctly. Malpighius, from this firſt obſervation, concludes with propriety, that the foetus exiſts in the egg before incubation, and that the rudiments of the embryo are even then deeply rooted. It is unneceſſary to mention how much this experiment differs from the opinion of Harvey; for he had obſerved nothing formed during the two firſt days of incubation; and, in his eſtimation, the firſt veſtige of a foetus is the animated point, which appears not till the third day. But Malpighius diſcovered that the rudiments of the whole foetus exiſt before incubation is commenced.

After aſcertaining this important fact, Malpighius proceeded to examine the cicatrice of unimpregnated eggs, which, as formerly remarked,

* Malpighii pullus in ovo.

marked, is ſmaller than in thoſe that have received an impregnation. Its margin is often irregular, and its texture ſometimes differs in different eggs. Near its centre, in place of a bubble including the foetus, there is a globular mole or unorganized maſs, which, when opened, preſents nothing like regularity or arrangement of parts: It has only ſome appendages filled with a thick but tranſparent liquor; and this unformed maſs is ſurrounded and enveloped in ſeveral concentric circles.

After ſix hours incubation, the cicatrice is conſiderably enlarged; and, in its centre, a bubble or globule formed by the amnios is eaſily diſtinguiſhable. This globule is filled with a fluid, in the middle of which the head and back-bone of the chick viſibly appear. Six hours after, every thing is enlarged, and, of courſe, more apparent to the eye. In ſix hours more, that is, 18 hours after the commencement of incubation, the head is larger, and the ſpine is lengthened; and, at the end of 24 hours, the head of the chick appears in a bended poſture, and the ſpine is of a whitiſh colour. The vertebrae are ranged on each ſide of the ſpine, like ſmall globules; and, nearly at the ſame time, the wings begin to ſprout, and the head, neck, and breaſt, are lengthened. At the end of 30 hours, nothing new appears; but all the parts are enlarged, and eſpecially the amnios. Round this membrane may be remarked the umbilical

veſſels,

veſſels, which are of a dark colour. In 38 hours, the chick has acquired more ſtrength; its head is very large, and three veſicles appear in it ſurrounded with membranes, which likewiſe include the ſpine of the back; through which, however, the vertebrae are ſtill viſible. At the end of 40 hours, it was admirable to obſerve, continues our author, the chick living in the centre of the liquor of the amnios. The back-bone was increaſed, the head was bended, the veſicles of the brain were leſs bare, the rudiments of the eyes appeared, the heart beat, and the blood circulated. Here Malpighius deſcribes veſſels and the circulation of the blood; and he thought, with reaſon, that, though the heart did not beat till 38 or 40 hours after incubation was begun, it nevertheleſs exiſted before, as well as the other parts of the chick. But, on examining the heart in a dark chamber, he obſerved nothing like luminous ſparks iſſuing from it, as Harvey ſeems to inſinuate.

At the end of the ſecond day, the foetus appeared ſwimming in the liquor of the amnios. The head, which ſeemed to be compoſed of veſicles, was bended; the back-bone and vertebrae were lengthened; the heart, which hung out of the breaſt, beat three times ſucceſſively, becauſe the fluid it contains is puſhed from the auricle into the ventricles, from the ventricles into the arteries, and, laſtly, into the umbilical veſſels. He remarks, that, having ſeparated the

chick

chick from the white of the egg, the motion of the heart continued for a whole day. In 14 hours more, or 62 hours from the beginning of incubation, the chick, though ſtronger, remained ſtill with its head bended in the liquor of the amnios: Veins and arteries were perceived in the brain; and the lineaments of the eyes, and of the ſpinal marrow, appeared. At the end of three days, the body of the chick was crooked. Beſide the two eyes, five veſicles filled with liquor appeared in the head; the rudiments of the thighs and of the wings were diſcernible; the body began to take on fleſh; and the pupils of the eyes, and likewiſe the cryſtalline and vitreous humours, were diſtinguiſhable. At the termination of the fourth day, the veſicles of the brain were nearer each other; the proceſſes of the vertebrae were longer; the wings and thighs had become ſtronger, in proportion as they grew longer; the whole body was covered with an unctuous fleſh; the umbilical veſſels had pierced through the abdomen; and the heart was concealed within the breaſt, which was now ſhut up by a thin membrane. On the fifth, and at the end of the ſixth day, the veſicles of the brain began to be covered; the ſpinal marrow, which was now more ſolid, was divided into two parts, and advanced along the trunk; the thighs and wings were longer, and the wings were unfolded; the abdomen was ſhut and tumified; the liver was diſtinctly viſible,

and

and it was of a dark colour; the two ventricles of the heart beat; the body of the chick was covered with ſkin; and the points of the feathers began to appear. On the ſeventh day, the head was very large; the brain was covered with its membranes; the beak appeared between the two eyes; the wings, the thighs, and the legs, had acquired their perfect form; the heart ſeemed to be compoſed of two ventricles, like two contiguous globules, united at their ſuperior part with the auricles; and two ſucceſſive pulſes were remarked both in the ventricles and auricles, as if there had been two ſeparate hearts.

But I will follow Malpighius no farther. The remainder of the detail regards the growth and perfection of the parts till the chick breaks the ſhell in which it is incloſed, and becomes an inhabitant of a new world. The heart is the laſt part that aſſumes its proper figure, by the union of its ventricles, which happens not till the eleventh day.

We are now in a condition to form a diſtinct judgment concerning the value of Harvey's experiments. It is probable that this celebrated anatomiſt did not make uſe of the microſcope, (which was, indeed, very imperfectly known in his days), otherwiſe he never would have affirmed, that there was no difference between the cicatrice of impregnated and unimpregnated eggs; he never would have ſaid, that the ſemen of the male produced no change upon the egg, and

and particularly upon the cicatrice; he never would have advanced, that nothing was perceptible before the end of the third day; that the animated point appeared firſt; and that the white point was transformed into the animated point: He would have perceived that the white point was the bubble or globule which contained the whole apparatus of generation; and that all the rudiments of the foetus commenced there from the moment of receiving the impregnation of the cock: He would likewiſe have diſcovered, that, without this impregnation, it contains nothing but an unformed maſs, which could never become animated; becauſe, in fact, it is not organized like an animal, and becauſe it is only after this maſs, which ought to be regarded as a collection of the organic particles of the female ſemen, is penetrated by the organic particles of the male ſemen, that an animal is formed. This formation is inſtantaneous; but the motions of the new animal are imperceptible till 40 hours after the proceſs of incubation has commenced: He would not have aſſured us that the heart is firſt formed, and that the other parts are ſucceſſively joined to it by juxta-poſition; ſince it is apparent, from the experiments of Malpighius, that the rudiments of all the parts are formed at once, but that they become perceptible only in proportion as they are ſucceſſively unfolded: Laſtly, if he had ſeen, as Malpighius ſaw, he would not have poſitively aſſerted, that no im-

preſſion

preſſion of the male ſeed remained in the eggs, and that it was only by contagion that they were impregnated, &c.

It is likewiſe proper to remark, that what Harvey has ſaid concerning the parts of generation of the cock is by no means exact. He affirms, that the cock has no penis capable of entering the vagina of the hen. It is certain, however, that this animal, in place of one penis, has a couple, which both act at the ſame time; and this action is a vigorous compreſſion, if not an actual copulation *. It is by this double organ that the cock throws his ſeminal liquor into the uterus of the hen.

Let us now compare Harvey's experiments upon female deer with thoſe of De Graaff upon female rabbits; and, though De Graaff believed, as Harvey did, that all animals proceed from eggs, we ſhall find a great difference in the manner in which theſe two anatomiſts have perceived the firſt formation, or rather the expanſion, of the foetuſes of viviparous animals.

After exerting every effort to prove, by arguments drawn from comparative anatomy, that the teſticles of viviparous females are true ovaria, Graaff explains the manner in which the eggs are detached from the ovaria, and fall into the *horns* of the uterus. He then relates the remarks he made upon a rabbit which he diſſected half an hour after copulation. The horns of

* See Regn. Graaf, p. 242.

of the uterus, he ſays, were uncommonly red; there was no change either in the ovaria, or in the eggs which they contained; and there was not the leaſt appearance of ſemen in the vagina, in the uterus, or in the *Fallopian tubes*.

Having diſſected another rabbit, ſix hours after copulation, he obſerved, that the follicles, or coats, which, in his eſtimation, contain the eggs in the ovarium, were become red; but he found no male ſemen either in the ovaria or any where elſe. Twenty hours after copulation, he diſſected a third; he remarked in one ovarium three, and in the other five follicles much altered; for, inſtead of being clear and limpid, they had become opaque and reddiſh. In another, diſſected twenty-ſeven hours after copulation, the horns of the uterus, and the ſuperior canals which terminate in them, were ſtill more red; and their extremities embraced the ovarium on all ſides. In another, which was opened forty hours after copulation, he found in one ovarium ſeven, and in the other three follicles changed. Fifty-two hours after copulation, he examined another, and found in one ovarium four changed follicles, and one in the other; and having opened theſe follicles, he diſcovered in them a kind of glandulous liquor, with a ſmall cavity in the middle, where he could perceive no fluid, which made him ſuſpect that the tranſparent liquor uſually contained in the follicles, and which, he ſays, is incloſed in its own membranes, might have

have been discharged by some kind of rupture. He searched for this matter in the canals which terminate in the horns of the uterus, and in the horns themselves; but he found nothing. He only remarked, that the membranes which line the horns of the uterus were much swelled. In another rabbit, dissected three days after copulation, he observed, that the superior extremity of the canal, which terminates in the horns of the uterus, straitly embraced the ovarium on every side: And, having separated it from the ovarium, he remarked, in the right ovarium, three follicles somewhat larger and harder than usual. After searching, with great care, the canals above mentioned, he discovered, he says, an egg in the right canal, and two more in the right horn of the uterus, so small that they exceeded not mustard seeds. These little eggs had each two membranes, and the internal one was filled with a very limpid liquor. Having examined the other ovarium, he found four changed follicles; three of them were whiter, and had likewise some limpid liquor in their centres; but the fourth was of a darker colour, and contained no liquor, which made him suspect that the egg had escaped. He therefore searched the corresponding canal and horn of the uterus; he found an egg in the superior extremity of the horn, which was exactly similar to those he had discovered in the right horn. He alledges, that the eggs, when they are separated

rated from the ovarium, are ten times leſs than before their ſeparation ; and this difference in ſize, he imagines, is owing to the eggs, while in the ovarium, containing another matter, namely, the glandulous liquor which he remarked in the follicles.

Four days after copulation, he opened another rabbit, and found in one ovarium four, and in the other three follicles, void of eggs : In the horns correſponding to the ovaria, he found four eggs on one ſide, and three in the other. Theſe eggs were larger than thoſe he had diſcovered three days after copulation. They were nearly of the ſize of the lead-ſhot uſed for ſhooting ſmall birds ; and he remarked, that, in theſe eggs, the interior membrane was ſeparated from the exterior, and appeared as if a ſecond egg was contained within the firſt. In another, diſſected five days after copulation, he found five empty follicles in the ovaria, and an equal number of eggs in the uterus, to which they adhered very firmly. Theſe eggs were as large as the ſhot employed for killing hares ; and the internal membrane was ſtill more apparent than in the laſt experiment. Having opened another rabbit, ſix days after copulation, he found in one of the ovaria ſix empty follicles, but only five eggs in the correſponding horn of the uterus ; and they ſeemed to be all accumulated into one maſs : In the other ovarium, he ſaw four empty follicles, and found but one egg in the

correſponding

correſponding horn. Theſe eggs were of the ſize of the largeſt fowling ſhot. Seven days after copulation, our anatomiſt opened another rabbit, and he found in the ovaria ſome empty follicles, which were larger, harder, and more red than thoſe he had formerly obſerved; and he perceived as many tranſparent tumors in different parts of the uterus; and, having opened them, he took out the eggs, which were as large as ſmall *piſtol* bullets. The internal membrane was more diſtinct than formerly; and within this membrane he ſaw nothing but a very clear liquor. In another, diſſected eight days after copulation, he found in the uterus the tumors or cells which contain the egg; but they adhered ſo ſtrongly to the uterus, that he could not detach them. In another, which he opened nine days after copulation, he found the cells containing the eggs greatly enlarged; and he perceived, in the middle of the liquor incloſed by the internal membrane, a ſmall thin cloud. In another, which he opened ten days after copulation, the ſmall cloud was thicker and darker, and formed an oblong body like a little worm. Laſtly, twelve days after copulation, he diſtinctly perceived the embryo, which, though two days before it was only an oblong body, was now ſo apparent, that he could diſtinguiſh its different members. In the region of the breaſt, he ſaw two red and two white points, and, in the abdomen, a mucilaginous reddiſh ſubſtance. Fourteen

teen days after copulation, the head of the foetus was large and tranſparent; the eyes were prominent; the mouth was open; the rudiments of the ears appeared; the back-bone was whitiſh, and bended towards the ſternum; and ſmall blood-veſſels aroſe from each ſide of it, the ramifications of which extended along the back as far as the legs: The two red points were conſiderably enlarged, and appeared like the rudiments of the ventricles of the heart; on each ſide of the red points he ſaw two white ones, which were the rudiments of the lungs. In the abdomen he ſaw the rudiments of the liver, which was reddiſh, and a ſmall body twiſted like a thread, which was the ſtomach and inteſtines. After this, till the 31ſt day, when the female rabbit brings forth, there was nothing to be remarked but the gradual expanſion and growth of the parts which were already formed.

From theſe experiments, De Graaf concludes, that all viviparous females have eggs; that theſe eggs are contained in the ovaria or teſticles; that they cannot be ſeparated till they are fecundated by the ſemen of the male; becauſe, ſays he, the glandulous liquor, by means of which the eggs are enabled to eſcape from their follicles, is not ſecreted till after an impregnation by the male. He alledges, that thoſe who imagine they have ſeen pretty large eggs in three days, have been deceived; becauſe, in his opinion, the eggs, though fecundated, remain longer in the ovarium, um, and, in place of augmenting, they become ten times leſs than formerly, and they never begin to grow till after their deſcent from the ovaria into the uterus.

By comparing theſe obſervations of De Graaff with thoſe of Harvey, we will eaſily perceive that the latter has miſſed the principal facts: And, though there are ſeveral errors both in the reaſoning and in the experiments of De Graaff, this anatomiſt, as well as Malpighius, have diſcovered themſelves to be better obſervers than Harvey. They agree in all fundamental points, and both of them contradict Harvey. He perceived not the alterations which take place in the ovaria; he ſaw not in the uterus thoſe ſmall globules which contain the materials of generation, and which are called eggs by De Graaff. He never ſuſpected that the foetus exiſted in the egg; and, though his experiments give us tolerably exact ideas concerning what happens during the growth of the foetus, he furniſhes no information concerning the commencement of fecundation, nor concerning the firſt expanſion of the foetus. Schrader, a Dutch phyſician, who had a great veneration for Harvey, acknowledges that he cannot be truſted in many articles, and particularly in what relates to the firſt formation of the embryo; for the chick really exiſts in the egg before incubation; and, he ſays, that Joſeph of Aromatarius was the firſt who made this material obfervation *. Befides, though Harvey alledged that all animals proceeded from eggs, he never imagined that the tefticles of females contained eggs; and it was only from a comparifon between the fac, which he believed to be formed in the uterus of viviparous animals, with the growth and covering of the eggs in oviparous animals, that he maintained that all animals were produced from eggs; and even this is but a repetition of what Ariftotle had faid before him. Steno was the firft who pretended to have difcovered eggs in the ovaria of females. He fays, that, in diffecting a female fea-dog, he perceived eggs in the tefticles, though this animal be viviparous; and he adds, that the tefticles of women are analogous to the ovaria of oviparous animals, whether the eggs themfelves fall into the uterus, or only the matter which they contain. Steno firft difcovered thefe fuppofed eggs; De Graaff is willing to affume the difcovery to himfelf; and Swammerdam warmly difputes the point with him, and alledges that Van-Horn had feen them before De Graaff. This laft writer, it is true, has been accufed of afferting many things which have been contradicted by experiments: He even pretended, that a certain judgment might be formed of the number of foetufes in the uterus, by the number of cicatrices or empty follicles in the ovaria. In this he is contradicted by the experiments

* See Obf. Jufti Schraderi, Amft. 1674.

experiments of Verrheyen *, by thoſe of M. Mery †, and by ſome of his own, where he found fewer eggs in the uterus, than cicatrices in the ovaria. Beſides, we ſhall demonſtrate that what he ſays concerning the ſeparation of the eggs, and the manner in which they deſcend into the uterus, is by no means exact; that no eggs exiſt in the teſticles of females; that what is ſeen in the uterus is not an egg; and that the ſyſtems which have been deduced from the obſervations of this celebrated anatomiſt are perfectly chimerical.

This pretended diſcovery of eggs in the teſticles of females attracted the attention of moſt anatomiſts. They only found, however, in the teſticles of viviparous females, ſmall bladders. Theſe they heſitated not to conſider as real eggs; and, therefore, they called the teſticles *ovaria*, and the veſicles *eggs*. They aſſerted alſo, like De Graaff, that theſe eggs differed in ſize in the ſame ovarium; that the largeſt in the ovaria of women exceeded not the bulk of a ſmall pea; that they are very ſmall in young girls; but that they increaſed with age and intercourſe with men; that not above 20 could be reckoned in each ovarium; that theſe eggs are fecundated in the ovarium by the ſpiritous part of the male ſemen; that they then ſeparate and fall into the uterus through the Fallopian tubes, where the

 foetus

* Tom. 2. chap. 3. edit. De Bruxelles, 1710.

† Hiſt. de l'acad. 1701.

foetus is formed of the internal ſubſtance of the egg, and the placenta of its external parts; that the glandulous matter, which exiſts not in the ovarium till after a fruitful embrace, compreſſes the egg, and excludes it from the ovarium, &c. But, though Malpighius, who examined more accurately, detected many errors committed by theſe anatomiſts even before they were received; yet moſt phyſicians adopted the opinion of De Graaff, without regarding the obſervations of Malpighius, which were nevertheleſs of the greateſt importance, and which received much weight from the experiments of his diſciple Valiſnieri.

Malpighius and Valiſnieri, of all naturaliſts, appear to have written with moſt judgment and acuteneſs on the ſubject of generation. We ſhall, therefore, give an account of their experiments and remarks.

Malpighius, after examining the teſticles of a number of cows and other female animals, aſſures us, that he found, in the teſticles of all of them, veſicles of different ſizes, whether the females were very young or adults. Theſe veſicles are enveloped in a pretty thick membrane, the inſide of which is interſperſed with blood-veſſels; and they are filled with a kind of lymph or liquor, which coagulates and hardens by the heat of a fire, like the white of an egg.

In proceſs of time, a firm yellow body adheres to the teſticles. It is prominent, increaſes to to the ſize of a cherry, and occupies the greateſt part of the ovarium. This body conſiſts of ſeveral angular lobes, the poſition of which is very irregular, and it is covered with a coat or membrane interſperſed with nerves and blood-veſſels. The form and appearance of this yellow body varies conſiderably at different times. When it exceeds not the ſize of a grain of millet, it is roundiſh, and its ſubſtance, when cut, has a warty appearance. We often find an external covering round the veſicles of the ovaria, which conſiſts of the ſame ſubſtance with the yellow bodies.

When the yellow body has become nearly of the ſize of a pea, it reſembles a pear; and, in the centre of it, there is a ſmall cavity filled with liquor. The ſame thing may be remarked when it is as large as a cherry. In ſome of theſe yellow bodies, after they have arrived at full maturity, Malpighius affirms that he ſaw, towards the centre, a ſmall egg with its appendages, about the ſize of a millet ſeed; and, after they had diſcharged theſe eggs, they were flaccid and empty. They then reſembled a cavernous canal; and the void cavities were as large as peas. He conceived that Nature deſigned this yellow glandulous body for the preſervation of the egg, and for making it eſcape from the teſticles; and that, perhaps, it contributed to the formation of the egg; conſequently, he remarks, the veſicles which are at all times found in the ovarium, and always differ in ſize, are not the true eggs which receive the impregnation, but ſerve only to produce the yellow bodies in which the eggs are formed. Beſides, though theſe yellow bodies are not always found in every ovarium; yet we always find the rudiments of them. Malpighius found the marks of them in new born heifers, in cows with calf, and in pregnant women; and, therefore, he properly concludes, that theſe yellow glandulous bodies are not, as De Graaff aſſerts, an effect of impregnation. The yellow bodies, he remarks, produce unfecundated eggs, which fall out of the ovarium independent of any communication with the male, and alſo thoſe which fall after impregnation. When the impregnated eggs fall into the uterus, every thing proceeds in the manner deſcribed by De Graaff.

Theſe obſervations of Malpighius demonſtrate, that the teſticles of females are not real ovaria; that the veſicles they contain are not eggs; that theſe veſicles never fall into the uterus; and that the teſticles, like thoſe of males, are only reſervoirs containing a liquor which may be regarded as female ſemen in an imperfect ſtate. This ſemen is matured in the yellow glandulous bodies, of which it fills the internal cavities, and flows out after the yellow bodies have acquired their full ſize.

But, before we form a judgment concerning this important point, we muſt attend to the remarks of Valiſnieri.

In the year 1692, Valiſnieri began his experiments upon the teſticles of the ſow. The teſticles of the ſow differ from thoſe of cows, of mares, of ſheep, of ſhe-aſſes, of female-dogs, of ſhe-goats, of women, and of moſt viviparous animals; for they reſemble a ſmall bunch of raiſins, the grains of which are round and prominent on the outſide; between theſe grains are ſmaller ones, which have not acquired full maturity. Theſe grains appear not to be covered with a common membrane. They are, ſays he, analogous to the yellow bodies obſerved in cows by Malpighius; they are round, and of a reddiſh colour; their ſurface is interſperſed with blood-veſſels, like the eggs of viviparous animals; and the whole grains together form a maſs which is larger than the ovarium. With a little addreſs, theſe grains may be ſeparated from the ovarium, and each of them, after ſeparation, leaves a nitch or depreſſion.

Theſe glandulous bodies are not of the ſame colour. In ſome ſows they are more red; in others more clear; and they are of all ſizes, from the ſmalleſt ſeed, to that of a raiſin. On opening them, a triangular cavity appears, filled with a limpid liquor, which coagulates with heat, and becomes white, like that which is contained in the veſicles. Valiſnieri expected to find the egg in ſome of theſe cavities: But in this he was diſappointed; though he made a careful ſearch into all the glandulous bodies of a number

number of ſows, and other animals, he could never diſcover the egg, which Malpighius affirms he once or twice found.

Under theſe glandulous bodies, the veſicles of the ovarium appeared. They were more or leſs numerous, according as the glandulous bodies were larger or ſmaller ; for, in proportion to the largeneſs of the glandulous bodies, the veſicles diminiſhed. Some veſicles were of the ſize of a lentil, and others exceeded not that of a millet ſeed. In the teſticles, when raw, from 20 to 35 veſicles might be reckoned ; but, when boiled, a much greater number appear, and they are ſo firmly attached, that they cannot be ſeparated without breaking ſome of them.

Having examined the teſticles of a young ſow, which had never brought forth, he found, as in the others, the glandulous bodies ; and their triangular cavities were likewiſe filled with lymph ; but he could not diſcover any eggs either in the one or the other. The veſicles of this young ſow were more numerous than in thoſe which had brought forth, or thoſe which were impregnated at the time of examination. In the teſticles of another ſow, which was far advanced in pregnancy, Valiſnieri found two of the largeſt glandulous bodies, which were flaccid and empty, and others, of a leſſer ſize, in their ordinary ſtate ; and, in ſeveral others which he diſſected when with young, he remarked, that the number of glandulous bodies was always greater than the

number

number of foetuſes. This fact confirms what we obſerved concerning the experiments of De Graaff, and proves that they are by no means exact. What he calls follicles of the ovarium are only the glandulous bodies, the number of which always exceeds that of the foetuſes. In the ovaria of a ſow, two or three months old, the teſticles were pretty large, and interſperſed with veſicles of a conſiderable ſize. Among the veſicles, the beginnings of four glandulous bodies appeared in one teſticle, and of ſeven in the other.

After theſe experiments upon ſows, Valiſnieri repeats thoſe of Malpighius upon cows, and he found them to be exactly conformable to truth. He indeed acknowledges, that he was never able to diſcover the egg which Malpighius imagined he had ſeen once or twice in the interior cavities of the glandulous bodies. After a fruitleſs ſearch in the teſticles of ſo many different females, it was natural to think that Valiſnieri would at leaſt have doubted the exiſtence of ſuch eggs. But prejudice in favour of ſyſtem made him admit, contrary to his own experience, the exiſtence of eggs, which neither he nor any other man ever ſaw, or ever will ſee.

It is, perhaps, impoſſible to make a greater number, or more exact experiments, than thoſe of Valiſnieri. Among other animals, he examined the ewe, and found, that ſhe never has more glandulous bodies in her teſticles than foetuſes in the uterus. In young ewes, which were never impregnated, there is but one glandulous body in each teſticle, and, when one is emptied, it is ſucceeded by another; if a ewe has one foetus in the uterus, ſhe has only one glandulous body in her teſticles; and if ſhe has two foetuſes, ſhe has likewiſe two glandulous bodies. This glandulous body occupies the greateſt part of the teſticle; and, after it is emptied and diſappears, another begins to grow for the purpoſe of a future generation.

In the teſticles of a ſhe-aſs, he found veſicles as large as ſmall cherries; which is an evident proof that they are not eggs, as it would be impoſſible for them to paſs, by the Fallopian tubes, into the uterus.

The teſticles of female wolves, dogs, and foxes, are covered with a membrane, like a purſe, which is an expanſion of that which ſurrounds the *horns* of the uterus. In a bitch which began to be in ſeaſon, but had not been approached by the male, Valiſnieri found the internal part of this purſe, which does not adhere to the teſticle, moiſtened with a liquor that reſembled whey, and two glandulous bodies in the right teſticle, about two lines in diameter, and which occupied nearly the whole extent of the teſticle. Each glandulous body had a ſmall nipple, with a diſtinct fiſſure, from which, without preſſing it, there iſſued a liquor like clear whey; he therefore concluded, that this liquor was the ſame

which

which he found in the purſe. He blew into this fiſſure with a pipe, and the whole glandulous body immediately ſwelled ; and, having introduced a briſtle, he eaſily penetrated to its bottom. He opened the body on that ſide where he had introduced the briſtle, and found an internal cavity which communicated with the nipple, and contained a conſiderable quantity of liquor. Valiſnieri was always in hopes of diſcovering the egg ; but theſe hopes, notwithſtanding all his reſearches, were uniformly fruſtrated. He likewiſe found, in the left teſticle, two glandulous bodies very ſimilar to thoſe in the right. He boiled two of theſe glandulous bodies, hoping that, by this means, he might diſcover the egg ; but ſtill without any meaſure of ſucceſs.

Having diſſected another bitch four or five days after ſhe had received the male, he found in the teſticles three glandulous bodies exactly ſimilar to the former. He ſearched every where for the egg ; but he was ſtill diſappointed. By the aſſiſtance of the microſcope, he diſcovered the glandulous bodies to be a net-work, compoſed of an infinite number of globular veſicles, which ſerved to filtre the liquor that iſſued through the nipple.

He then opened another bitch which was not in ſeaſon, and having tried to introduce air between the teſticle and the purſe which covered it, he found that it dilated like a bladder filled with air. Having removed the purſe, he diſcovered

vered two glandulous bodies upon the teſticles; but they had neither nipple nor fiſſure, and no liquor diſtilled from them.

In another bitch that had brought forth about five whelps two months before, he found five glandulous bodies; but they were much diminiſhed in ſize, and they began to diſappear, without leaving any cicatrices. There remained only a ſmall cavity in their centre; but it contained no liquor.

Not ſatisfied with theſe, and many other experiments, Valiſnieri, who paſſionately deſired to diſcover this pretended egg, called together the beſt anatomiſts his country afforded, and, among others, M. Morgagni; and, having opened a young bitch that was for the firſt time in ſeaſon, and that had been covered three days before, they examined the veſicles of the teſticles, the glandulous bodies with their nipples, their canals, and the liquor in their internal cavities; but they could perceive no eggs. He then, with the ſame intention, made experiments on ſhe-goats, foxes, cats, a number of mice, &c. In the teſticles of all theſe animals, he uniformly found the veſicles, and frequently the glandulous bodies, with the liquor they contained; but no egg ever appeared.

In fine, being deſirous of examining the teſticles of women, he had an opportunity of opening a young country-woman, who had been ſome years married, and who was killed by a

fall

fall from a tree. Though of a robuſt and vigorous conſtitution, ſhe had never born any children. He endeavoured to diſcover if the cauſe of her barrenneſs exiſted in the teſticles; and he found that the veſicles were all filled with a blackiſh and corrupted matter.

In a young girl of eighteen years of age, who had been brought up in a convent, and who had every appearance of real virginity, he found the right teſticle a little longer than the left: It was of an oval figure, and its ſurface was ſomewhat unequal. This inequality was occaſioned by five or ſix veſicles which protruded on the outſide of the teſticle. One of theſe veſicles, which was more prominent than the reſt, he opened, and a quantity of lymph ruſhed out. This veſicle was ſurrounded with a glandulous ſubſtance, in the ſhape of a creſcent, and of a reddiſh yellow colour. He cut the teſticle tranſverſely, and found a number of veſicles filled with limpid liquor; and he remarked, that the Fallopian tube of this teſticle was redder and ſomewhat longer than the other, as he had often obſerved in other animals when they were in ſeaſon.

The left teſticle was whiter, and its ſurface more ſmooth; for, though ſome veſicles were a little prominent, none of them were in the form of nipples; they were all ſimilar to each other, and the correſponding Fallopian tube was neither ſwelled nor red.

In

In the body of a girl, aged five years, he found the teſticles with their veſicles, their blood-veſſels, and their nerves.

In the teſticles of a woman of ſixty years, he diſcovered ſome veſicles, and the veſtiges of a glandulous ſubſtance, like large points of an obſcure yellowiſh brown colour.

From all theſe obſervations, Valiſnieri concludes, that the work of generation is carried on in the female teſticles, which he continued to regard as ovaria, though he never could find any eggs in them, and though, on the contrary, he had diſcovered that the veſicles were not eggs. He ſays, likewiſe, that, for the impregnation of the egg, it is not neceſſary that the male ſemen ſhould enter the uterus. He ſuppoſes, that the egg eſcapes through the nipple of the glandulous body, after being impregnated in the ovarium; that it then falls into the Fallopian tube; that it gradually deſcends, and at laſt attaches itſelf to the uterus: He adds, that he is fully perſuaded, that the egg is concealed in the cavity of the glandulous body, though neither he nor any other anatomiſt was ever able to diſcover it.

In his eſtimation, the ſpirit of the male ſeed aſcends into the ovarium, penetrates the egg, and gives motion to the foetus which previouſly exiſted in the egg. In the ovarium of the original mother of mankind, he obſerves, were eggs, which contained not only all the children ſhe produced, but of the whole human race. If this

this chain of infinite individuals contained in one be incomprehenſible to us, it is entirely owing to the imbecillity of our minds, of which we have daily proofs. But it is not, therefore, leſs conſonant to truth, that all the animals which have exiſted, or can exiſt, were created at once, and were all included in their firſt mothers. The reſemblance of children to their parents is owing, he continues, to the imagination, which acts ſo forcibly on the foetus as to produce ſtains, monſtroſities, diſorder of parts, and extraordinary concretions, as well as perfect ſimilarities.

This ſyſtem of eggs, though it explains nothing, and has no foundation in Nature, would have obtained the univerſal ſuffrages of phyſicians, if, nearly about the ſame time, another opinion had not ſprung up, founded upon the diſcovery of ſpermatic animals.

This diſcovery, which we owe to Leeuwenhoek and Hartſoeker, was confirmed by Andry, Valiſnieri, Bourguet, and many other obſervers. I ſhall relate what has been advanced concerning thoſe ſpermatic animals which are found in the ſemen of all males. Their number is ſo great, that the ſemen ſeems to be entirely compoſed of them; and Leeuwenhoek pretends to have ſeen many millions of them in a drop leſs than the ſmalleſt grain of ſand. Though none of them appear in females, they are found in the emitted ſemen of all males, in the teſticles, and in the veſiculae ſeminales. When the ſemen of a man is expofed to a moderate heat, it thickens, and the motion of all the animalcules is fuddenly ftopped. But, when allowed to cool, it dilutes, and the animals continue in motion till the liquor again thickens by evaporating. The more this fluid is diluted, the number of animalcules is augmented; and, when greatly diluted by the addition of water, the whole fubftance of the fluid feems to be compofed of animals. When the motion of the animalcules is about to ceafe, either on account of heat or of drying, they appear to approach nearer each other, to have a common circular motion in the centre of the fmall drop under obfervation, and to perifh, all of them, at the fame inftant. But, when the quantity of liquor is greater, it is eafy to diftinguifh them dying in fucceffion.

Thefe animalcules are faid to be of different figures in different animals; but they are all long, thin, without any members, and move with rapidity in every direction. The fluid in which they are contained, as formerly remarked, is much heavier than blood. The femen of a bull, when chemically analyfed by Verrheyen, yielded firft phlegm, then a confiderable quantity of foetid oil, a very fmall proportion of volatile falt, and more earth than he expected *. This author was furprifed that he could draw no fpirit from the diftillation of femen; and, as he imagined it contained a great quantity of fpirits,

* See Verrheyen fup. anat. tom. 2. p. 69.

ſpirits, he attributed the evaporation of them to their ſubtility. But may we not ſuppoſe, with more probability, that it contains little or no ſpirits? Neither the conſiſtence, nor the odour of this fluid, indicate the preſence of ardent ſpirits, which never abound but in fermented liquors; and, with regard to volatile ſpirits, the horns, bones, and ſolid parts of animals, afford more of them than the fluids. What has received the appellation of ſeminal ſpirits, *aura ſeminalis*, among anatomiſts, has, perhaps, no exiſtence; and it is certain, that the moving bodies apparent in the ſeminal fluid are not agitated by theſe ſpirits. But, that we may be enabled to pronounce more clearly concerning the nature of the ſemen, and of its animalcules, we ſhall preſent the reader with the principal obſervations which have been made on the ſubject.

Leeuwenhoek, having examined the ſemen of a cock, perceived a number of animals ſimilar to river eels; but they were ſo minute, that 50,000 of them were not equal in bulk to a grain of ſand. Of thoſe in the ſemen of a rat, it required, he ſays, many millions to make the thickneſs of a hair, &c. This excellent obſerver was perſuaded, that the whole ſubſtance of the ſemen was only a maſs of animalcules. He ſaw theſe animalcules in the ſemen of men, of quadrupeds, of birds, of fiſhes, and of inſects. In the ſemen of a graſs-hopper, the animalcules were long, and extremely thin. They appeared, he ſays, to be attached by their ſuperior end; and the other end, which he calls their tail, had a briſk motion, like that of the tail of a ſerpent when its head is fixed. In the ſemen of young animals, when examined before they have any ſexual appetite, he alledges that he ſaw the ſame minute animals, and that they had no motion: But, when the ſeaſon of love arrived, the animalcules moved with great vivacity.

In the ſemen of a male frog, he ſaw animalcules; but, at firſt, they were imperfect, and had no motion: Some time after, he found them alive. They were ſo minute, he obſerves, that ten thouſand of them were only equal in bulk to a ſingle egg of the female.

In the ſemen of a man and that of a dog, he pretended to ſee two ſpecies of animalcules, reſembling males and females. Having ſhut up the ſemen of the dog in a ſmall vial, he ſays, that a great number of animalcules died the firſt day; that, on the ſecond and third day, ſtill more of them died; and that few of them were alive on the fourth day. But, having repeated this experiment on the ſemen of the ſame dog, he found, at the end of ſeven days, the animalcules as briſk and lively as if they had been newly extracted from the animal: And, having opened a bitch that, ſome time before the experiment, had been three times covered by the ſame dog, he could not perceive, with his naked eye, any male ſemen in the uterus or its appendages;

but,

but, by the aſſiſtance of the microſcope, he found the ſpermatic animals of the dog in both *horns* of the uterus: In that part of the uterus which is neareſt the vagina, he diſcovered great numbers, which evidently proves, ſays he, that the male ſemen enters the uterus, or, at leaſt, that the ſpermatic animals of the dog had arrived there by their own motion, which enables them to paſs over 4 or 5 inches in half an hour. In the uterus of a female rabbit, which had juſt received the male, he obſerved an infinite number of ſpermatic animals. He remarks, that the bodies of theſe animals are round; that they have long tails; and that they often change their figure, eſpecially when the fluid in which they ſwim begins to dry up.

Theſe experiments of Leeuwenhoek were repeated by ſeveral people, who found them exactly conſonant to truth. But Dalenpatius, and ſome others, who were inclined to exceed Leeuwenhoek in acuteneſs of viſion, alledged that, in the ſemen of a man, they not only found animals reſembling tadpoles, whoſe bodies appeared to be as large as a grain of corn, with tails about four times as long as their trunks, and which moved with great agility; but, what is ſtill more amazing, Dalenpatius ſaw one of theſe animals break through its coat or covering: It was then no more an animalcule, but a real human body, in which he eaſily diſtinguiſhed the two arms and legs, the breaſt and the head *. But it is apparent, from the very figures given by this author, of the embryo which he pretended to have feen efcape from its covering, that the fact is abfolutely falfe. He believed that he faw what he defcribes; but he was deceived; for this embryo, according to his defcription, was more completely formed, at the time of its tranfmigration from the condition of a fpermatic worm, than it is in the uterus of the mother at the end of the fourth or fifth week. Hence this obfervation of Dalenpatius, inftead of being confirmed by future experiments, has been rejected by all naturalifts, the moft acute of whom have only been able to difcover in the feminal fluid of man round or oblong bodies, which appear to have long tails, but no members of any kind.

One would be tempted to think that Plato had been acquainted with thefe fpermatic animals which are transformed into men; for, at the end of his Timaeus †, he fays, 'Vulva quoque 'matrixque in foeminis eadem ratione animal 'avidum generandi, quando procul a foetu per 'aetatis florem, aut ultra diutius detinetur, aegre 'fert moram ac plurimum indignatur, paffimque 'per corpus oberrans, meatus fpiritus intercludit, 'refpirare non finit, extremis vexat anguftiis, 'morbis denique omnibus premit, quoufque u- 'trorumque

* See nouvelles de la republic des lettres, ann. 1699, p. 552.

† P. 1088, edit. Ficini.

'trorumque cupido amorque, quasi ex arboribus 'foetum fructumve producunt, ipsum deinde de-'cerpunt, et in matricem velut agrum inspar-'gunt: Hinc animalia primum talia, ut nec prop-'ter parvitatem videantur, necdum appareant 'formata, concipiunt; mox quae conflaverant, 'explicant, ingentia intus enutriunt, demum e-'ducunt in lucem, animaliumque generationem 'perficiunt.' Hippocrates, in his treatise *De Diaeta*, seems likewise to insinuate that the semen of animals is full of animalcules. Democritus talks of certain worms which assume the human figure; and Aristotle tells us, that the first men issued from the earth in the form of worms. But neither the authority of Plato, of Aristotle, of Hippocrates, of Democritus, nor that of Dalenpatius, will ever be able to bestow credibility on a notion which is repugnant to the repeated experience and observation of all those who have hitherto made inquiries into this subject.

Valisnieri and Bourguet perceived small worms in the semen of a rabbit: One of their extremities was longer than the other; they were very active in their motions, and beat the fluid with their tails: Sometimes they raised themselves to the top of the liquor, and sometimes sunk to the bottom; at other times they turned round, and twisted like serpents: In fine, says Valisnieri, I clearly perceived them to be real animals: 'E gli riconobbi, e gli gindicai senza

‘ dubitamento alcuno per veri, veriſſimi, arcive-
‘ riſſimi vermi *.’ This author, though prejudiced in favour of the ovular ſyſtem, admitted the actual exiſtence of ſpermatic animals.

M. Andry pretends, that he could find no animals in human ſemen previous to the age of puberty; that they exiſt not in the ſemen of very old men; that there are few of them in thoſe who are affected with the venereal diſeaſe, and that theſe few are in a languiſhing ſtate; that none of them appear alive in impotent perſons; and that the animalcules in the ſemen of men have a larger head than thoſe of other animals, which correſponds, he obſerves, with the figure of the foetus and infant; and he adds, that thoſe who uſe women too frequently have generally few or no animalcules in their ſemen.

Leeuwenhoek, Andry, and others, exerted every effort againſt the egg-ſyſtem: They diſcovered in the ſemen of all males living animalcules; they proved that theſe animalcules could not be regarded ſimply as inhabitants of this fluid, ſince the quantity of them was larger than that of the fluid itſelf; and ſince nothing ſimilar to them exiſted either in the blood, or in any other of the animal fluids: They maintained, that, as females furniſhed no animalcules, their fecundity was ſolely derived from the males; that the exiſtence of living animals in the ſemen throws more light upon the nature of generation

* See opere del. Cav. Valiſnieri, tom. 2. p. 105.

ration than all the former discoveries on this subject; because the greatest difficulty in generation is to conceive how life is first produced, the future expansion and growth of the parts being only accessory operations; and, consequently, that not a doubt remained of these animalcules being destined to become men, or perfect animals, according to their species. When the improbability was objected to them, that millions of animalcules, all equally capable of becoming men, should be employed for this purpose, while only one of them was to enjoy the singular advantage of being admitted into the condition of humanity; when it was demanded of them, why this useless profusion of human germs was employed? they replied, That it corresponded with the usual magnificence of Nature; that, in plants and trees, millions of seeds were produced, while only a few of them succeeded; and that, therefore, we ought not to be surprised at the prodigious number of spermatic animals. When the extreme minuteness of a spermatic worm, compared with the body of a man, was mentioned to them as a difficulty, they answered, that the seeds of trees, of the elm, for example, were equally minute, when compared with the perfect individuals; and they added, with equal propriety, metaphysical arguments, by which they proved, that largeness and minuteness were only relations, and that the transition from small to great, or from great to small, was performed by Nature

Nature with greater facility than we could poſſibly imagine.

Beſides, they aſked, are there not frequent examples of the transformation of inſects? Do we not daily ſee ſmall aquatic worms, by ſimply throwing off their ſkin or covering, from which they received their external figure, transformed into winged animals? May not ſpermatic animalcules, by a ſimilar transformation, become perfect animals? Every thing, therefore, they conclude, concurs in eſtabliſhing this ſyſtem of generation, and in overturning that which is founded on the notion of eggs; and, though eggs really exiſted in viviparous animals, as well as in the oviparous, theſe eggs would only be the matter neceſſary for the growth and expanſion of the ſpermatic worm, which enters by the pedicle which attaches the egg to the ovarium, where it finds abundance of nouriſhment. All the worms which are ſo unfortunate as to miſs this paſſage through the pedicle into the egg, periſh, and that one alone which finds the proper road is transformed into a perfect animal. The difficulty of finding this paſſage is ſufficient to account for the great number and apparent profuſion of the ſpermatic animals. It is a million to one againſt any individual worm's finding this paſſage; but, to compenſate this difficulty, there are more than a million of worms. When a worm has once got poſſeſſion of an egg, no other can enter into it;

it; becauſe, ſay they, the firſt worm ſhuts up the paſſage; or rather, there is a valve at the entry to the pedicle, which plays while the egg is not perfectly full; but, when the worm has filled the egg, this valve will not open, though puſhed by a ſecond worm. Beſides, this valve is exceedingly well contrived; for, if the worm ſhould chance to deſcend through the paſſage by which it entered, the valve prevents its eſcape, and obliges it to remain till it be transformed. The ſpermatic worm then becomes a real foetus; and it is nouriſhed by the ſubſtance of the egg, and the membranes ſerve it for a covering; and, when the nouriſhment contained in the egg begins to fail, the foetus attaches itſelf to the internal ſurface of the uterus, and, by this means, extracts nouriſhment from the blood of the mother, till, by its weight, and the increaſe of its ſtrength, it at laſt breaks off all conection with the uterus, and iſſues into the world.

According to this ſyſtem, it was not the firſt woman, but the firſt man, who contained all mankind in his own body. The pre-exiſtent germs are no longer inanimate embryos locked up in eggs, and included, *in infinitum*, within each other. They are, on the contrary, ſmall animals or organized living *homunculi*, included in each other in endleſs ſucceſſion, and which, to render them men, or perfect animals, require nothing but expanſion, and a transformation ſimilar to that of winged inſects.

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As phyſicians are at preſent divided between the ſyſtem of ſpermatic worms, and that of eggs, and as every new writer upon generation has adopted either the one or the other of theſe hypotheſis, it is neceſſary to examine them with care, and to ſhow not only their inſufficiency to explain the phaenomena of generation, but that they reſt upon ſuppoſitions which are entirely deſtitute of probability.

Both ſyſtems ſuppoſe an infinite progreſſion, which, as formerly remarked, is a mere illuſion of the brain. A ſpermatic worm is more than a thouſand million of times ſmaller than a man. If, then, the body of a man be taken as an unit, the body of a ſpermatic worm will be expreſſed by the fraction $\frac{1}{10000000000}$, *i. e.* by a number conſiſting of ten cyphers; and, as man is to a ſpermatic worm of the firſt generation in the ſame proportion as this worm is to a worm of the ſecond generation, the ſize of this laſt ſpermatic worm will be expreſſed by a number conſiſting of 19 cyphers; for the ſame reaſon, the ſize of a ſpermatic worm of the third generation muſt be expreſſed by a number conſiſting of 28 cyphers, that of the fourth generation by 37 cyphers, that of the fifth generation by 46 cyphers, and that of the ſixth generation by 55 cyphers. To form an idea of the minuteneſs repreſented by this fraction, let us take the dimenſions of the ſphere of the univerſe from the Sun to Saturn; and, ſuppoſing the Sun to be a million

million of times larger than the Earth, and distant from Saturn a thousand solar diameters, we shall find that 45 cyphers are sufficient to express the number of cubic lines contained in this sphere; and, if we reduce each cubic line into a thousand million of atoms, no more than 54 cyphers will be necessary to express their number: Of course, a man will be proportionally greater, when compared with a spermatic worm of the sixth generation, than the sphere of the universe when compared to the smallest atom that can be seen with the assistance of a microscope. But, if this calculation were carried on to the 16th generation, the minuteness would exceed all powers of expression. It is apparent, therefore, that the probability of this hypothesis vanishes in proportion as the object diminishes. This calculation applies equally to eggs as to spermatic worms; and the want of probability is common to both. It will, no doubt, be objected, that, as matter is infinitely divisible, this gradual diminution of size is not impossible. To this I reply, that all infinities, whether in geometry or in arithmetic, are only mental abstractions, and have no actual existence in Nature. If the infinite divisibility of matter is to be regarded as an absolute infinite, it is easy to demonstrate, that, in this sense, it has no existence; for, if we once suppose the smallest possible atom, by the very supposition, this atom must be indivisible; because, if it were divisible, it it would not be the ſmalleſt poſſible atom, which is contrary to the ſuppoſition. It is, therefore, apparent, that every hypotheſis which admits an infinite progreſſion ought to be rejected not only as falſe, but as deſtitute of every veſtige of probability; and, as both the vermicular and ovular ſyſtems ſuppoſe ſuch a progreſſion, they ſhould be excluded for ever from philoſophy.

Theſe ſyſtems are liable to another objection: In the ovular ſyſtem, the firſt woman contained both male and female eggs; the male eggs could only give origin to males; but the female eggs muſt have contained millions of generations of both males and females: Hence every woman muſt have always contained a certain number of eggs capable of being unfolded *in infinitum*, and another number, which could only be unfolded once, and could have no farther operation in the ſeries of exiſtence. The ſame thing muſt take place in the vermicular ſyſtem. Hence we may conclude, that there is not the ſmalleſt degree of probability in hypotheſes of this nature.

A third difficulty ſtill remains, ariſing from the reſemblance of children ſometimes to the father, ſometimes to the mother, and ſometimes to both, and from the evident characters of ſpecific differences in mules and other monſtrous productions. If the foetus proceeds from the ſpermatic worm of the father, how comes the child to reſemble its mother? If the foetus pre-

exiſts

exifts in the egg of the mother, how fhould the child refemble its father? And, if the fpermatic worm of a horfe, or the egg of a fhe-afs, be the origin of the foetus, how fhould the mule partake of the nature and figure both of the horfe and afs?

Thefe general objections, though perfectly invincible, are not the only difficulties with which both fyftems are embarraffed. May it not be demanded of thofe who embrace the vermicular fyftem, how thefe worms are tranfformed, and wherein confifts the analogy between this transformation and that which infects undergo? The caterpillar which is to become a butterfly, paffes through a middle ftate, and, after it ceafes to be a chryfalis, is completely formed, has acquired its full growth, and is inftantly capable of generating: But, in the pretended transformation of the fpermatic worm of a man, there is no middle or chryfalis ftate; and, fuppofing it fhould happen during the firft days of conception, why is not the production of this chryfalis, in place of an unformed embryo, a perfect adult? Here all analogy ceafes; and, of courfe, the notion of the transformation of the fpermatic worm can receive no fupport from this quarter.

Befides, the worm which is to be transformed into a flie proceeds from an egg; this egg is impregnated by the copulation of the male and female, and it includes the foetus which is to pafs

into

into a chryſalis, before it arrives at the perfect ſtate of a flie, and before it acquires the power of generating. But the ſpermatic worm has no generative faculty; neither does it proceed from an egg: And, though it ſhould be ſuppoſed that the ſemen contains eggs which produce the ſpermatic animals, the ſame difficulty ſtill remains; for theſe ſuppoſed eggs are not a reſult of the copulation of two ſexes, like thoſe of inſects. Conſequently, the analogy fails here likewiſe; and the transformation of inſects, in place of ſtrengthening this hypotheſis, ſeems to deſtroy it entirely.

The ſeeds of vegetables are reſorted to, in order to account for the infinite number of ſpermatic animals: But this analogy does not apply; for all the ſpermatic animals, one only excepted, muſt abſolutely periſh. The ſeeds of vegetables, however, are not ſubject to the ſame neceſſity. When they become not vegetables themſelves, they nouriſh other organized bodies, and ſerve the purpoſes of growth and of reproduction to animals. But the prodigious ſuperfluity of ſpermatic animals can anſwer no end whatever. I make this remark, purely becauſe I wiſh to omit nothing that has been advanced on the ſubject; for I acknowledge, that no argument drawn from final cauſes can either eſtabliſh or deſtroy a phyſical theory.

The apparent equality in the number of ſpermatic animalcules in all animals, has alſo been objected

objected to by the ſupporters of this doctrine. If theſe animalcules are the immediate cauſe of generation, why is there no proportion between their numbers and thoſe of the young, which are various in men, quadrupeds, birds, fiſhes, and inſects? Beſides, there is no proportional difference in moſt ſpecies of ſpermatic animals, thoſe of a rat being nearly equal in ſize to thoſe of a man. Even when a difference in ſize takes place, it has no proportion to the bulk of the animals. The ſpermatic animals of the calmar, which is a ſmall fiſh, are a hundred thouſand times larger than thoſe of a man or of a dog. This is an additional proof that theſe worms are not the ſole and immediate cauſe of generation.

The particular objections to the ovular ſyſtem are not leſs weighty. If the foetus exiſted in the egg before the junction of the male and female, why do we not ſee the foetus in the egg before impregnation, as clearly as after it? We formerly mentioned, that Malpighius always found the foetus in eggs which had received the impregnation of the male, and could diſcover nothing but an unformed mole or maſs in the cicatrice of unimpregnated eggs. It is, therefore, evident, that the foetus is never formed till the egg has been impregnated.

Farther, we not only cannot diſcover the foetus in eggs before the intercourſe of the ſexes, but we have not been able to demonſtrate the exiſtence

existence of eggs in viviparous animals. Those physicians who pretend that the spermatic worm is the foetus inclosed in a coat or covering, are at least ascertained of the existence of spermatic worms; but those who maintain that the foetus pre-exists in the egg, have no evidence of the existence of the egg itself; for the probability of the non-existence of eggs in viviparous animals amounts almost to a certainty.

Though the partizans of the ovular system agree not as to what ought to be regarded as the real egg in the testicles of females, they all allow, however, that impregnation is accomplished in the testicles or ovarium. But they never consider, that, if this were the case, most foetuses would be found in the abdomen instead of the uterus; for, as the superior extremity of the Fallopian tube is unconnected with the ovarium, the pretended eggs would often fall into the abdomen. Now, we know this to be at least a very rare phaenomenon; and it is probable that it never happens but by means of some violent accident.

These objections and difficulties have not escaped the ingenious author of *Venus Physique*. But, as his work is in the hands of the public, and as it admits not of abridgement, we shall refer the reader to the book itself; and shall conclude with an account of a few particular experiments, some of which appeared to favour and others to contradict the above systems.

In

In the hiſtory of the Academy of Sciences, ann. 1701, ſome objections are propoſed by M. Mery againſt the egg-ſyſtem. This able anatomiſt maintained, with propriety, that the veſicles found in the teſticles of females are not eggs; that they adhere ſo firmly to the internal ſurface of the teſticle, as not to admit of a natural ſeparation; and that, though they could ſeparate from the ſubſtance of the teſticle, it was impoſſible for them to get out of it, becauſe the texture of the common membrane incloſing the whole teſticle is ſo firm and ſtrong, that it is impracticable to conceive the poſſibility of its being pierced by a veſicle, or round ſoft egg. And, as moſt anatomiſts and phyſicians were prepoſſeſſed in favour of the egg-ſyſtem, and imagined that the number of cicatrices in the teſticles correſponded with the number of foetuſes, M. Mery ſhowed ſuch a quantity of theſe cicatrices in the teſticles of a woman, as, upon the ſuppoſition of the truth of this ſyſtem, would have argued a fecundity beyond the power of credibility. Theſe difficulties ſtimulated other anatomiſts of the Academy, who were partizans of the eggs, to make new reſearches. M. Duverney examined the teſticles of cows and ſheep, and maintained, that the veſicles were eggs, becauſe ſome of them adhered leſs firmly to the teſticles than others; and that it was natural to ſuppoſe they ſeparated altogether when they arrived at full maturity; eſpecially as, by blowing into the cavity of the teſticle, the air paſſed between the veſicles and the adjacent parts. M. Mery ſimply replied, that this proof was inſufficient, as theſe veſicles were never ſeen ſeparate from the teſticles. M. Duverney farther obſerved the glandulous bodies upon the teſticles; but he never conſidered them as parts eſſential to generation, but as accidental excreſcences, like gall-nuts on the oak. M. Littre, whoſe prejudices in favour of eggs were ſtill ſtronger, maintained not only that the veſicles were eggs, but even aſſured us, that he diſcovered in one of them a well formed foetus, of which he could diſtinguiſh both the head and trunk; and he has even given their dimenſions. But, admitting this wonder, which never appeared to any eyes except his own, to be convinced of the doubtfulneſs of the fact, we have only to peruſe his memoir *. From his own deſcription, it appears that the uterus was ſchirrous, and the teſticle very much corrupted; that the veſicle or egg, which contained the pretended foetus, was much leſs than common, &c.

Nuck furniſhes us with a celebrated experiment in favour of eggs. He opened a bitch three days after copulation; he drew out one of the *horns* of the uterus, and tied it in the middle, ſo as to prevent the ſuperior part of the Fallopian tube from having any communication with the inferior. After this, he replaced the *horn*

* Année 1701, p. 111.

horn of the uterus, and closed the wound. Twenty-four hours afterwards, he again opened the wound, and found two foetuses in the superior part of the tube, that is, between the testicles and the ligature; and there was no foetus in the under part. In the other horn of the uterus that was not tied, he found three foetuses, regularly disposed; which proves, says he, that the foetus proceeds not from the male semen, but that it exists in the egg of the female. Supposing this experiment, which is single, had been often repeated with the same success, the conclusion the author draws from it is not legitimate: It proves no more than that the foetus may be formed in the superior part of the horn of the uterus, as well as in the inferior; and it is natural to think that, by the pressure of the ligature, the seminal liquor in the inferior part was forced out, and, of course, frustrated the work of generation in that region of the uterus.

This is all the length that anatomists and physicians have proceeded in the subject of generation. It only remains that I deliver the results of my own experiments and inquiries; and I shall leave the reader to judge whether my system be not infinitely more consonant to Nature than any of those which I have enumerated.

CHAP. VI.

Experiments on Generation.

I Often reflected on the above two ſyſtems of generation, and was daily more and more convinced that my theory was infinitely more probable. At length I began to ſuſpect that thoſe living organic particles, from which I thought all animals and vegetables derived their origin, might be recognized by the aſſiſtance of good glaſſes. My firſt notion was, that the ſpermatic animalcules found in the ſeminal fluid of all males, might probably be thoſe very organic particles; and I reaſoned in this manner. If all animals and vegetables contain an infinite number of organic particles, theſe particles ſhould be moſt abundant in their ſeeds, becauſe the ſeed is an extract from all the organic parts, and eſpecially from thoſe which are moſt analogous to the individual: Perhaps the ſpermatic animals found in the ſemen of males may actually be thoſe very organic particles, or, at leaſt, the firſt union or aſſemblages of them. But, if this be the caſe, then the ſemen of females ought to contain organic living particles, or animalcules, ſimilar to thoſe thofe of the male. They ought, for the fame reafon, to be found in the feeds of plants, in the nectarium, and in the ftamina, which are the moft effential parts of vegetables, and contain the organic particles neceffary for their reproduction. I therefore determined to examine with the microfcope the feminal liquors of males and females, and the germs of plants; and, at the fame time, I imagined that the cavities of the glandulous bodies of the uterus might be the refervoirs of the female femen. Having communicated my ideas of this fubject to my ingenious friends Mr Needham, M. Daubenton, M. Gueneau, and M. Dalibard, they encouraged me to commence a fet of experiments in order to throw light upon this myfterious operation of Nature. All of thefe gentlemen occafionally attended and affifted me; but particularly M. Daubenton, who was never abfent, and who was witnefs to every experiment I made.

I employed a double microfcope, which I had from Mr Needham, being the fame with which he made his numerous and ingenious obfervations *. This inftrument is infinitely preferable to thofe employed by Leeuwenhoek †.

* Publifhed in the year 1745.

† Here M. de Buffon mentions the advantages of the double microfcope, and fome precautions neceffary in the management of it, which, now that the inftrument is well known, and much improved fince the author wrote, it is unneceffary to tranflate.

EXPERIMENT I.

Having procured the ſeminal veſſels of a man who died a violent death, and whoſe body was ſtill warm, I extracted all the liquor from them, and put it in a vial. I examined, by the microſcope, a drop of this liquor, without any dilution. As ſoon as the vapours, which aroſe from the liquor, and obſcured the glaſs, were diſſipated, I obſerved pretty large filaments [plate III. fig. 1.], which, in ſome places, ſpread out into branches, and, in others, intermingled with each other. Theſe filaments clearly appeared to be agitated with an internal undulatory motion, like hollow tubes, which contained ſome moving ſubſtance. I ſaw diſtinctly [pl. III. fig. 2.] two of theſe filaments, which were joined longitudinally, ſeparate from each other in the middle, and alternately approach and recede, like two ſtretched cords, fixed by the ends, and drawn aſunder at the middle. Theſe filaments were compoſed of globules which touched one another, and reſembled a chaplet of beads. I then obſerved filaments [pl. III. fig. 3.] which were blown up, and ſwelled in certain places, and perceived ſmall oval globules iſſue from theſe ſwelled parts, which had a vibratory motion, like that of a pendulum [pl. III. fig. 4.] Theſe ſmall bodies were attached to the filaments by little threads, which

which gradually lengthened as the bodies moved: And, laſtly, I obſerved theſe ſmall bodies detach themſelves entirely from the large filament, and draw after them the little thread, which reſembled a tail. As the liquor was too thick, and the filaments too near each other, I diluted another drop with pure rain water, after ſatisfying myſelf that it contained no animalcules. I then perceived that the filaments were more diſtant from each other, and ſaw diſtinctly the motion of the ſmall bodies above taken notice of, [pl. III. fig. 5.] which was more free, and they appeared to ſwim with greater agility, and trailed their threads after them with greater eaſe; and, if I had not ſeen them ſeparate from the filaments, and draw the threads out of them, I ſhould have believed, from this ſecond obſervation, the moving bodies to be real animals, and their threads to be tails. After examining with great attention one of the filaments, which was three times thicker than the ſmall bodies, I perceived two of theſe bodies detach themſelves with much difficulty, and drag after them long ſlender threads, which impeded their motion.

This ſeminal liquor was at firſt too thick: But it gradually became more fluid, and, in leſs than an hour, it was almoſt tranſparent; and, in proportion as its fluidity augmented, the phaenomena changed, in the manner to be juſt mentioned.

EXPER. II.

When the ſeminal liquor became more fluid, the filaments diſappeared; but the ſmall bodies were exceedingly numerous [pl. III. fig. 6.]. Their motion, for the moſt part, reſembled that of a pendulum; each of them had a long thread, from which they evidently endeavoured to diſengage themſelves; their progreſſive motion was extremely ſlow, during which they vibrated to the right and left. At each vibration, they had a rolling unſteady motion; ſo that, beſides their horizontal vibrations, they roll or vibrate in a verticle direction; which proves theſe bodies to be of a globular figure, or at leaſt that their inferior part is not a flat baſe ſufficiently extenſive to keep them in one poſition.

EXPER. III.

At the end of two or three hours, when the liquor was more fluid, a ſtill greater number of theſe moving bodies appeared [pl. IV. fig. 7.]. They were more free of incumbrances; their threads were ſhorter; their progreſſive motion was more direct; and their horizontal vibration was greatly diminiſhed; for the longer the threads were, their vibratory motion was increa-

ſed,

ſed, and their progreſs forward was diminiſhed. The vertical vibration was ſtill apparent.

EXPER. IV.

In five or ſix hours, the liquor had almoſt all the fluidity it could acquire, without being decompoſed. We then diſcovered [pl. IV. fig. 8.] that moſt of theſe ſmall moving bodies were entirely diſengaged from their threads. Their figure was oval: They moved forward with conſiderable quickneſs; and by their motion backward and forward, and to every ſide, they had now more than ever the appearance of real animals. Thoſe which had tails or threads ſticking to them, ſeemed to have leſs vivacity than the others. Of thoſe which had no threads, ſome appeared to change both their figure and their ſize. Some were round; but the greateſt part of them were oval, and a few were thicker at the extremities than in the middle. The rolling and vibratory motions were ſtill perceptible.

EXPER. V.

In 12 hours, the liquor had depoſited, at the bottom of the vial, a kind of gelatinous, bluiſh, or rather aſh-coloured ſubſtance; and the fluid that

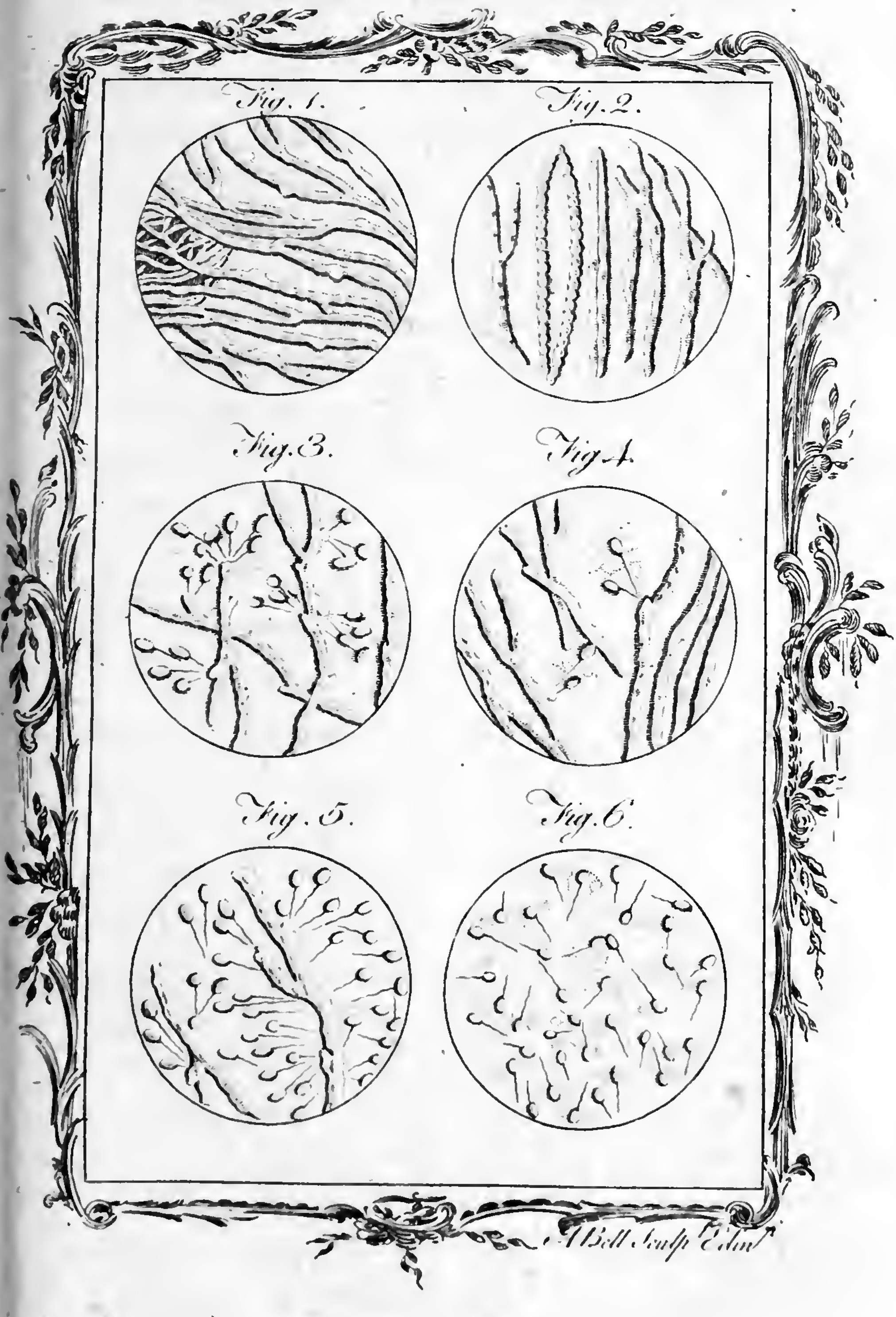
that ſwimmed on the top was nearly as clear as water, only it had a tincture of blue, like water in which a ſmall quantity of ſoap has been diſſolved. It ſtill, however, retained its viſcoſity. The little bodies, which were now entirely freed from their threads, moved with gread activity on all ſides, and ſome of them turned round their centres. Moſt of them were oval, though ſome of them were round. I have ſeen them change figures, and from oval become round: I have ſeen them divide, and, from a ſingle oval or globule, ſeparate into two. Their activity always increaſed as their ſize diminiſhed.

EXPER. VI.

At the end of 24 hours, the liquor had depoſited a greater quantity of gelatinous matter, which I diluted, with ſome difficulty, in water. It appeared to conſiſt of a multitude of opaque tubes reſembling lace, but without any regularity or the ſmalleſt motion. In the clear ſemen itſelf, there were a few ſmall bodies ſtill moving; next day their number was ſtill farther diminiſhed. After this, nothing was to be ſeen but globules without the leaſt appearance of motion.

Theſe experiments were often repeated with great exactneſs; and they convinced me that the threads which adhere to the moving bodies are not tails, nor any part proper to theſe bodies; for

Plate 3.



for the tails or threads have no proportion to the reſt of the body; they are of different dimenſions, though the bodies are always nearly of the ſame ſize at the ſame time. The motion of the globule is embarraſſed in proportion to the length of the tail. When the tail is too long, it ſometimes prevents the progreſſive motion altogether, leaving nothing but the vibrations from right to left; and the globules make evident efforts to diſentangle themſelves from this incumbrance.

EXPER. VII.

Having procured the ſeminal fluid of another man recently dead, I put a pretty large drop of it on the glaſs, which ſoon liquified without any mixture. It had the appearance of a cloſe network, the filaments of which were of a conſiderable length and thickneſs, and they ſeemed to proceed from the thickeſt part of the liquor, [pl. IV. fig. 9.]. Theſe filaments ſeparated in proportion as the liquor became more fluid; and at laſt they divided into globules, which ſeemed at firſt to have too little force to put them in motion: But their power of moving increaſed as they receded from the filaments, and they appeared to make conſiderable efforts to diſengage themſelves. In this manner each of them gradually drew tails of different lengths out of the filaments.

filaments. Some of theſe tails were ſo long and ſo thin, that they had no proportion to the bodies, which were always more or leſs embarraſſed, according to the length of the threads or tails. When the tail was long, the angle of the vibratory motion was increaſed; and, when the tail was ſhort, the progreſſive motion was more conſpicuous.

EXPER. VIII.

I continued my obſervations, almoſt without interruption, for 14 hours, and I diſcovered, that the length of the tails or threads gradually diminiſhed, and became ſo thin and delicate, that their extremities ſucceſſively ceaſed to be viſible; and at laſt the whole diſappeared. The horizontal vibrations of the globules then ceaſed, and their progreſſive motion was direct, though they ſtill had verticle oſcillations, or rather, they rolled like a veſſel at ſea. The ſmall bodies, when deprived of their tails, were oval and tranſparent, and reſembled thoſe pretended animals which are ſeen in oyſter water on the 6th or 7th day, or thoſe found in the jelly of roaſted veal at the end of the 4th day.

EXPER. IX.

Between the 10th and 12th hour, the liquor was become very fluid, and all the globules appeared

peared to proceed in troops from one ſide of the drop [pl. IV. fig. 10.]. They paſſed over the field of the microſcope in leſs than four ſeconds; they marched in lines of ſeven or eight in front; and ſucceeded each other without interruption, like the defiling of ſoldiers. I obſerved this ſingular phaenomenon for more than five minutes; and, as the current of animals did not then ceaſe, I was deſirous of diſcovering the cauſe. I therefore gently ſhifted the glaſs, and perceived that all theſe moving globules proceeded from a kind of mucilage, [pl. IV. fig. 11.] or net-work of filaments, which continually produced them, and with more rapidity and copiouſneſs than the filaments had done ten hours before. There was ſtill a difference more remarkable between the globules produced by the liquor, when thick, and thoſe produced when it was more fluid; for, in the latter caſe, they drew no threads or tails after them, their motion was quicker, and they went in flocks like ſheep. I examined the mucilage from which they proceeded for a long time, and perceived that it gradually diminiſhed and was converted into moving globules, till more than one half of it was deſtroyed. After which, the liquor being too dry, this mucilage became obſcure in the middle, and it was ſurrounded with ſmall threads, forming ſquare intervals, [pl. IV. fig. 12.]. Theſe ſmall threads ſeemed to be compoſed of the bodies of the moving globules which had been killed by the drying of the

the liquor, and the whole resembled the web of a spider besprinkled with drops of dew.

EXPER. X.

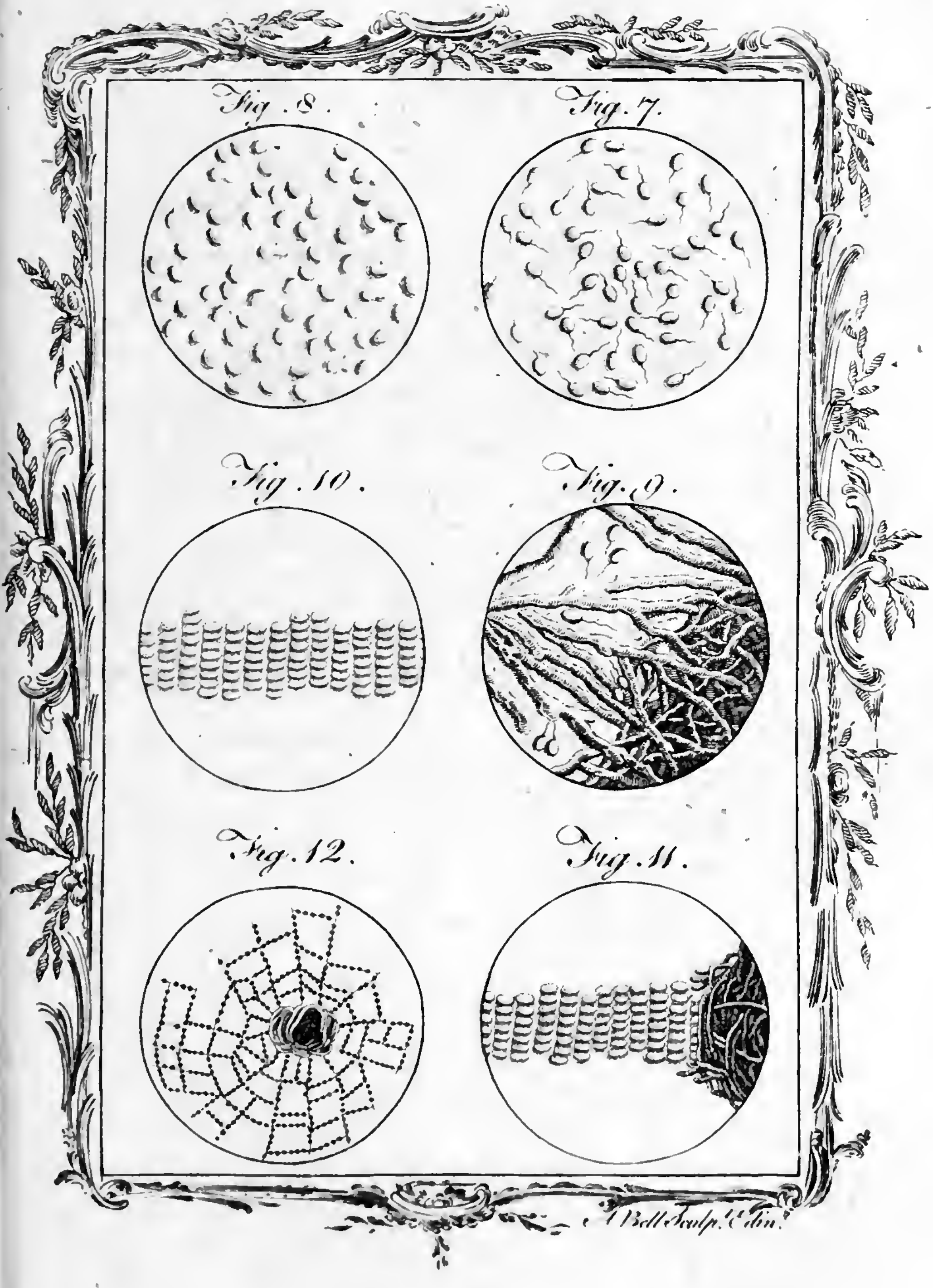
By the first experiments, I perceived that these small moving bodies changed their figures; and I imagined, that, in general, they diminished in bulk, though I was not then altogether certain of the fact. But my subsequent observations removed every doubt. At the 12th and 13th hour, the bodies were visibly smaller; but, as they diminished in bulk, their specific gravity increased, especially when they ceased to move, which they generally did all at once, and fell down to the bottom in the form of an ash-coloured sediment, which was perceptible by the naked eye; and, by the assistance of the microscope, it appeared to be composed of globules attached to one another, sometimes by threads, and at other times in groups, but always in a regular manner.

EXPER. XI.

Having procured the fresh semen of a dog, I observed that this liquor was clear, and had very little tenacity. I examined it without the addition of water, and I perceived moving bodies

almost

Plate 4.



almoſt entirely ſimilar to thoſe in the human ſemen, [pl. V. fig. 13.]. Their tails and their form were almoſt precifely the ſame with thoſe repreſented in pl. IV. fig. 7. where the liquor had been liquified for two or three hours. I in vain ſearched this liquor for the filaments which appeared in that of men. I only remarked ſome long and very delicate threads, exactly ſimilar to thoſe which ſerved for tails to the globules. Theſe threads contained no globules; neither had they any motion. The globules with tails ſeemed to move with more vivacity than thoſe in the human ſemen. They had hardly any horizontal vibrations; but they always rolled vertically. Their number was not great; and, though their progreſſive motion was quicker, they took up ſome time in paſſing over the field of the microſcope. I examined this liquor during three hours, and could obſerve no change. I continued my examination, from time to time, for ſeveral days, and remarked, that the number of moving bodies gradually diminiſhed. On the ſecond day, the greateſt part of them had loſt their tails: On the third, very few of them retained their tails; on the fourth, however, ſome tails ſtill adhered. The liquor had now depoſited a whitiſh ſediment, which appeared to be compoſed of globules without motion, and ſome ſmall threads that ſeemed to be the tails which had ſeparated from the globules. Some globules appeared to have dead ones attached to them;

them; for their figure differed from that of thoſe in motion, [pl. V. fig. 14.]: They were larger than the moving globules, or the dead ones at the bottom of the liquor, and ſeemed to have a kind of fiſſure or opening.

EXPER. XII.

At another time I examined the ſeminal fluid of the ſame dog, and perceived the ſame phaenomena which have been deſcribed. I farther obſerved, in a drop of this liquor, a mucilaginous part, [pl. V. fig. 15.] from which globules iſſued as in Exper. IX. and theſe globules formed a current, and moved in regular troops. This mucilage appeared to be agitated internally with a ſwelling or undulating motion, which produced ſmall protuberances in different parts; and theſe protuberances iſſued ſuddenly in the form of globules, which moved briſkly forward in the ſame direction. Theſe globules differed not from the others, except that they iſſued from the mucilage without tails. Some of them, I remarked, changed their figure; they lengthened themſelves till they reſembled ſmall cylinders; after which the extremities of the cylinders ſwelled, and divided by the middle into two globules, and both of them moved on in the ſame direction with the reſt.

EXPER.

EXPER. XIII.

The ſmall glaſs which contained this liquor having been overturned by accident, I took, from the ſame dog, another quantity of ſemen. But, whether the animal had been fatigued by too frequent emiſſions, or from ſome other cauſe, this ſeminal liquor contained nothing: It was tranſparent and viſcous, like the ſerum of blood; and, though I examined it, at different times, for 24 hours, I could perceive no moving bodies, no mucilage, nor, in a word, any thing ſimilar to what I had formerly ſeen.

EXPER. XIV.

I then opened a dog, and took out the teſticles, and the veſſels adhering to them; but I remarked, that he had no ſeminal veſſels: The ſemen of this animal probably paſſes directly from the teſticles into the urethra. Though the dog was full grown and vigorous, I found very little ſemen in the teſticles. I examined with the microſcope the ſmall quantity I could collect; but could perceive no moving bodies: I ſaw only a great number of very minute globules, the greateſt part of which were motionleſs; and ſome of the ſmalleſt of them ſeemed to move towards each other. But of this I could not be certain; becauſe the ſmall drops dried in a minute or two after they were put upon the glaſs.

EXPER. XV.

I cut the teſticles of this dog into two parts, put them into a glaſs-veſſel, with as much water as was ſufficient to cover them, and corked up the glaſs. Three days after, I examined this infuſion with a view to diſcover if the fleſh contained any moving bodies, and I perceived in the water of this infuſion a great number of moving bodies, ſome of them of a globular, others of an oval figure, and entirely reſembling thoſe I had ſeen in the ſeminal fluid of the former dog, except that they had no threads or tails: They moved in all directions with great vivacity. I obſerved, during a long time, theſe bodies, which appeared to be animated, and I perceived ſeveral of them change their figures before my eyes. Some of them lengthened, others contracted, and others ſwelled at the two extremities. The whole of them ſeemed to turn on their centres; ſome of them were larger, and others ſmaller; but the whole were in motion, and reſembled, both in ſize and figure, thoſe which were deſcribed in Exper. IV.

EXPER.

EXPER. XVI.

Next day, the number of moving globules was ſtill increaſed; but they were ſmaller; their motion more rapid and more irregular; and their form and manner of moving were different, and appeared to be more confuſed: The day after, and the following days, till the 20th, moving bodies ſtill appeared in this water. They daily diminiſhed in ſize, and at laſt became ſo ſmall that they could hardly be perceived; but the laſt of them I was able to diſtinguiſh on the 18th and 20th days, moved with the ſame rapidity as ever. On the top of the water there was a pellicle which appeared to be compoſed of the ſkins or coverings of the moving bodies, of ſmall threads, &c. But no motion appeared in it. This pellicle and the moving bodies could not be introduced into the liquor by means of the external air; for the bottle was always cloſely corked.

EXPER. XVII.

I opened ſucceſſively, on different days, ten rabbits, in order to examine their ſeminal fluid. In the firſt, ſecond, and third, I found not a ſingle drop, either in the teſticles or ſeminal veſſels, though I was certain that two of them were fathers of a numerous progeny. I imagined that the preſence of the female might be neceſſary for the ſecretion of the ſemen; I therefore put males and females by pairs into ſeparate cages, ſo conſtructed that they could not poſſibly copulate. Neither did this ſcheme at firſt ſucceed; for I opened two of them without finding any ſemen. In the ſixth, however, which was a large white rabbit, full of vigour, I found as much liquor in the ſeminal veſſels as would fill a ſmall coffee-ſpoon. This matter reſembled the jelly of meat, was of a citron colour, and almoſt tranſparent. Having examined it with the microſcope, it gradually ſeparated into filaments and large globules, ſeveral of which were attached to each other like a ſtring of beads; but I could diſcover no diſtinct motion; only, as the matter diſſolved, it formed a kind of current, by which the filaments and globules were carried down to one ſide of the glaſs. I waited till the matter ſhould become more fluid; but I was diſappointed; for, after liquifying a little, it dried up, and I could obſerve nothing farther than what I have already deſcribed. I then added water to it, but without ſucceſs; for the water ſeemed not to penetrate or dilute the matter.

EXPER. XVIII.

I opened another rabbit, and found only a ſmall quantity of ſeminal matter, which had hardly any

any of the yellow colour, and was more fluid than the former. As the quantity was very ſmall, I was apprehenſive leſt it ſhould dry too ſuddenly; I therefore inſtantly mixed it with water, and could perceive in it neither the filaments nor the ſtrings of beads that I had obſerved in the other; but I diſcovered the large globules, and farther remarked, that they had a kind of trembling reſtleſs motion. They had alſo a progreſſive motion; but it was very ſlow: Some of them moved round others, and moſt of them appeared to turn round their centres. I could proceed no farther in my obſervations, becauſe the liquor dried ſuddenly up.

EXPER. XIX.

Having diſſected another rabbit that had been placed in the ſame circumſtances, I found no ſeminal liquor; but, in the ſeminal veſſels of another, I found nearly as much congealed matter as in Exper. XVII. I examined this matter without diſcovering any thing. I therefore took the whole, and, adding to it a double quantity of water, ſhook the mixture violently in a glaſs. I then left it to ſettle for ten minutes; after which I examined a drop taken from the ſurface, and perceived the large globules formerly mentioned; but they were few in number, and perfectly detached from one another. They moved towards each other; but this motion was ſo ſlow, as to be hardly perceptible. Two or three hours after, the globules ſeemed to be diminiſhed in ſize; their motion was more ſenſible; and they turned upon their centres. Though their trembling was more apparent than their progreſſive motion; yet they plainly changed places in an irregular manner, with reſpect to each other. In ſix or ſeven hours, the globules were become ſmaller, and their activity was greater. Their number appeared to be great, and all their motions were ſenſible. Next day there was a prodigious multitude of moving globules, and they were at leaſt three times ſmaller than at firſt. I continued my obſervations for eight days, and I perceived that ſeveral of the globules joined; and, though all motion ceaſed after this union, it appeared to be ſuperficial and accidental only. Some of them were larger, and others leſs; though moſt of them were ſpherical, ſome were oval, and others cylindrical. The largeſt were moſt tranſparent; and the ſmalleſt were almoſt black. This difference could proceed from no accident in the light; for they were always of the ſame colour, whatever was their ſituation: The motion of the ſmall globules was likewiſe more rapid. The whole gradually diminiſhed in ſize; ſo that, on the eighth day, they were ſo ſmall, that it was with the utmoſt difficulty I could diſtinguiſh them, and at laſt they totally diſappeared.

EXPER.

EXPER. XX.

In fine, having, with great difficulty, procured the ſeminal liquor of another rabbit, in the very ſtate in which it is conveyed into the female, I remarked, that it was much more fluid than that which was extracted from the ſeminal veſſels; and the phaenomena it preſented were alſo very different: For, in this liquor there were moving globules, filaments without motion, and a kind of globules with tails or threads, ſimilar to thoſe in the ſeminal fluid of man and of the dog, only theſe laſt appeared to be leſs, and more active [Pl. V. fig. 17.]. They traverſed, in an inſtant, the field of the microſcope: Their tails ſeemed to be much ſhorter than thoſe of other ſpermatic animals; and I acknowledge, that I was uncertain whether ſome of theſe tails were not deceptions occaſioned by the track of the globules in the liquor; for they moved with ſuch rapidity, that I could hardly obſerve them; and beſides, the liquor, though ſufficiently fluid, dried very ſuddenly.

EXPER. XXI.

Having procured, at different times, the teſticles and ſeminal veſſels of 12 or 13 rams, recently after they were killed, I could not find, either

either in the epidydimis or ſeminal veſſels, a quantity of ſemen ſufficient for obſervation. In the ſmall drops I could collect, I found nothing but globules without motion. As theſe experiments were made in March, I imagined that, by repeating them in October, which is the time of rutting, I might find more liquor in the veſſels. I cut ſeveral teſticles in two longitudinally, and having collected a ſmall drop of liquor, I ſtill could perceive nothing but motionleſs globules of different ſizes.

EXPER. XXII.

I took three teſticles of three different rams, cut them into four parts, and put each of them into a glaſs-veſſel, with as much water as was ſufficient to cover them, and then ſhut the veſſels ſo cloſe as to exclude the air. I allowed the teſticles to infuſe during four days; after which I examined the liquor in each glaſs with the microſcope, and found the whole full of moving bodies; moſt of which were oval, and ſome of them globular. They were equally large, and greatly reſembled thoſe deſcribed in Exper. VIII. Their motion was not rapid, but equal, uniform, and in all directions. In each liquor, the moving bodies were nearly of the ſame ſize; but, in the one they were larger, in the other leſs, and, in the third, ſtill more minute: They had no tails;

tails; neither were there, in the liquor, any threads or filaments. They often changed their figures, and seemed successively to cast their skin or outer covering. They daily became smaller, and, on the 16th day, they were so small as scarcely to be visible.

EXPER. XXIII.

In the following October, I opened a ram, and found a great quantity of seminal liquor in the epidydimis. Having examined it with the microscope, I saw such an innumerable multitude of moving bodies, that the liquor seemed to be entirely composed of them. As the liquor was too thick, I diluted it with water; but I was astonished to find, that the water had stopped all motion in the bodies; though I saw them distinctly in the liquor, they were all at absolute rest. Having frequently repeated the same experiment, I discovered, that cold water, which diluted the seminal liquors of other animals, made that of the ram coagulate.

EXPER. XXIV.

I then opened another ram, and, to prevent the liquor from coagulating by cold, I left the parts of generation in the body of the animal, which

which was covered with warm cloths. This precaution afforded me an opportunity of examining with eafe the feminal liquor of many rams in its fluid ftate. It was filled with an infinite number of oblong moving bodies, [p. V. fig. 18.] which ran about in every direction. But, whenever the liquor cooled, all motion inftantly ceafed; fo that I could never obferve the fame drop above a minute or two. When I diluted the liquor with warm water, the bodies continued to move for three or four minutes. The moving bodies were fo numerous, that, though the liquor was diluted, almoft all of them touched each other. They were all of the fame fize and figure. None of them had tails. Their motion was not rapid; and, when the liquor began to coagulate, they fuffered no change in their form.

EXPER. XXV.

As I was perfuaded, both by my theory, and the experiments made by others upon this fubject, that the female, as well as the male, poffeffed a prolific feminal fluid; and, as I had no doubt but that the glandulous bodies of the tefticles, where prejudiced anatomifts had in vain fearched for the egg, were the refervoirs of this fluid; I purchafed feveral dogs and bitches, and male and female rabbits, which were kept fepa-

rate

rate from each other: And that I might have an object to compare with the female fluid, I again examined the ſeminal liquor of a dog, which had been emitted in the natural manner. I found the moving bodies in the ſame ſtate, and attended with the ſame circumſtances as formerly [pl. VI. fig. 19.].

EXPER. XXVI.

A live bitch was next diſſected, which had been four or five days in ſeaſon, without having any communication with the male. The teſticles were as large as filberds. On one of them I found a red prominent glandulous body of the ſize of a pea, which had a perfect reſemblance to a little nipple, with a viſible fiſſure, that had two lips, one of which was more prominent than the other. Having opened this fiſſure, a liquor diſtilled from it, which we collected for examination. The teſticles were then returned into the body of the animal, which was ſtill alive, in order to preſerve them from cooling. I then examined this liquor with the microſcope, and had the ſatisfaction of perceiving, at the firſt glance, moving bodies with tails, exactly ſimilar to thoſe which we had obſerved in the ſeminal fluid of the dog [pl. VI. fig. 20.]. Meſſrs Needham and Daubenton, who were preſent, were ſo ſtruck with this reſemblance, that they could not

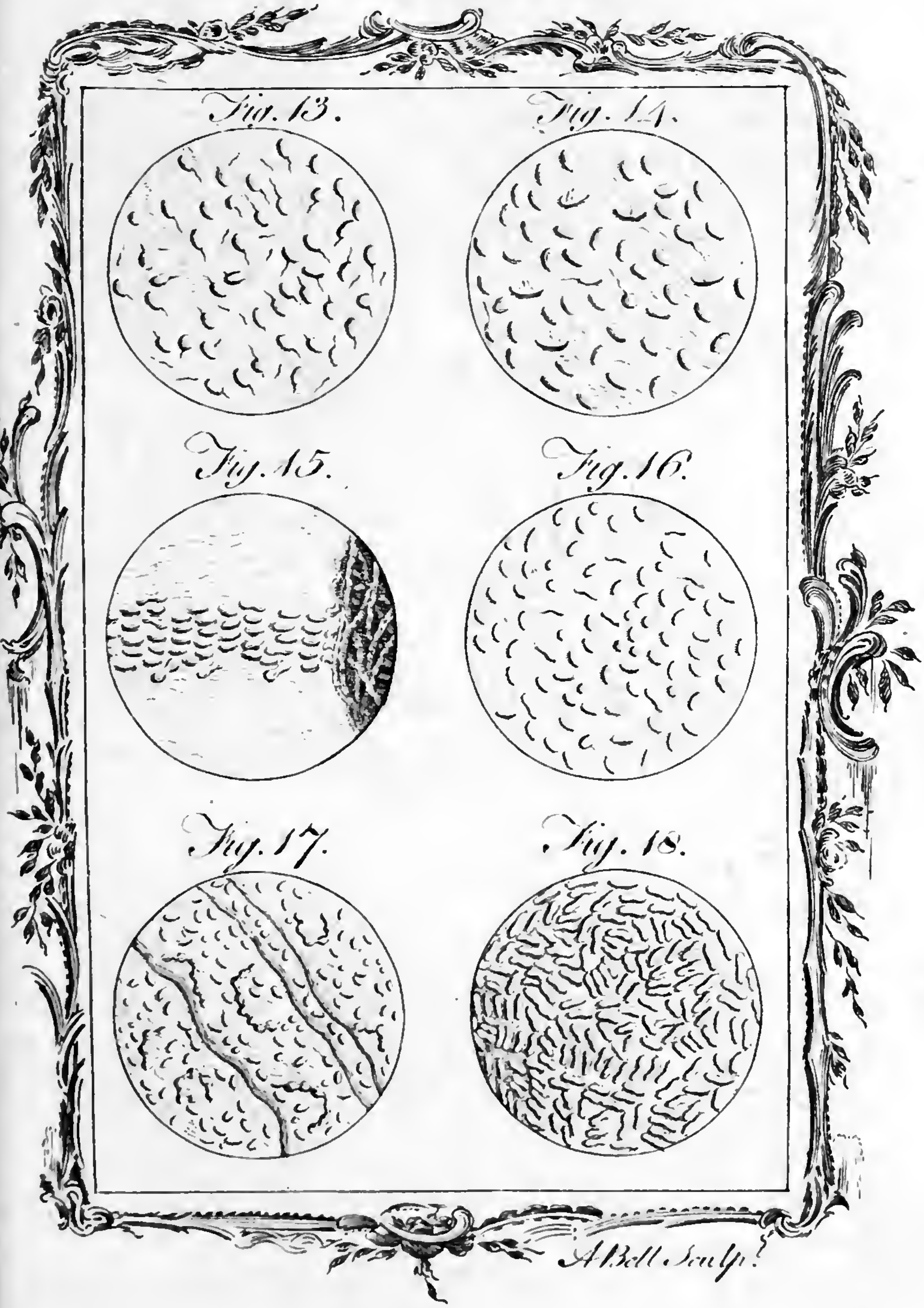
be

be perſuaded that the ſpermatic animals were not the very ſame; and they imagined that I had forgotten to change the object-glaſs, or rather, that the ſame pick-tooth with which the drops of the female fluid were collected, had alſo been employed in collecting thoſe of the male. Mr Needham, therefore, changed both the object-glaſs and the pick-tooth, and took a freſh drop from the fiſſure of the glandulous body, and examined it firſt with his own eyes. He again ſaw the very ſame moving bodies, and was fully convinced, not only of the exiſtence of ſpermatic animals in the ſeminal fluid of the female, but alſo of their reſemblance to thoſe in the ſemen of the male. We repeated the experiment with freſh drops no leſs than ten times, in all of which the phaenomena were exactly the ſame.

EXPER. XXVII.

Having then examined the other teſticle, I found an unripe glandulous body, which was ſmaller, and leſs red than the former, and had no fiſſure; but, after opening it with a ſcalpel, I found no liquor. Upon the external ſurface of this teſticle, there were ſome lymphatic veſicles. I pierced one of them with a lancet, and there iſſued a clear liquor, to which I immediately applied the microſcope. But it contained nothing ſimilar to what we diſcovered in that

Plate V.



that of the glandulous body. It was a tranſparent liquor, compoſed of very ſmall globules, without any motion. After repeating this experiment ſeveral times, I was convinced, that the liquor in the veſicles is only a ſpecies of lymph, which contains nothing animated or ſimilar to what we perceive in the female ſemen, which is ſecreted and matured in the glandulous bodies.

EXPER. XXVIII.

Some time after, another bitch was opened, which had been ſeven or eight days in ſeaſon, and had not received the male. I examined the teſticles, and upon each I found a glandulous body in full perfection. The firſt was half open, and had a canal which penetrated the teſticle, and was full of ſeminal fluid; the ſecond was larger and more prominent, and the fiſſure or canal that contained the fluid was below the nipple, which protruded outward. I took the liquor out of both the glandulous bodies, and, on compariſon, found them entirely ſimilar. This ſeminal liquor of the female is equally fluid with that of the male. After examining the liquors extracted from each teſticle, I found in them the very ſame moving bodies [pl. VI. fig. 21.]. I perceived at leiſure the ſame phaenomena that I had obſerved in the ſeminal liquor of the other bitch; I ſaw ſeveral globules which moved with great

great rapidity, which endeavoured to disengage themselves from the mucilage that surrounded them, and which dragged tails or threads after them. Their number was equally great with that in the male semen.

EXPER. XXIX.

I squeezed the whole liquor out of these two glandulous bodies, and put it into the glass of a watch. The quantity was sufficient to serve for four or five hours observation. I remarked that it deposited a kind of sediment, or at least began to thicken. I took a drop of the thickest part of the liquor, and having examined it, I discovered that the mucilaginous part of the semen was condensed, and formed a kind of net-work. From the anterior edge of this net-work, there issued a current of globules which moved with great rapidity [pl. VI. fig. 22.]. These globules were extremely active and lively, and they appeared to be divested of their mucilaginous coverings and of their tails. This stream of globules resembled the motion of the blood in the veins; for they seemed not only to be animated, but to be pushed on by some common force, which obliged them to follow each other in troops or rows. From this experiment, and from the 11th and 12th, I concluded, that, when the fluid begins to coagulate or grow thick, the active

tive globules break their mucilaginous covering, and eſcape at that ſide where the liquor is moſt fluid. They had no threads or tails, and moſt of them were oval, and ſeemed to be flat below; for they had no rolling motion.

EXPER. XXX.

I opened the horns of the uterus longitudinally, and having ſqueezed a little liquor out of them, I found it exhibited preciſely the ſame phaenomena with that obtained from the glandulous bodies. Theſe glandulous bodies are ſo ſituated, that they can eaſily pour their liquor upon the horns of the uterus: And I am perſuaded that, during the whole ſeaſon of love, there is a perpetual diſtillation of this liquor from the glandulous bodies into the horns of the uterus; that this diſtillation continues till the glandulous bodies be entirely emptied; and that they are gradually effaced, leaving only behind them a ſmall reddiſh cicatrice on the external ſurface of the teſticle.

EXPER. XXXI.

I mixed the ſeminal liquor of the female with an equal portion of that of the male, which was recently emitted; but the moving bodies, and every circumſtance, were ſo entirely the ſame, that

that I could make no diſtinction between thoſe of the male and thoſe of the female.

EXPER. XXXII.

Having diſſected a young bitch that had never been in ſeaſon, I diſcovered on one of the teſticles only, a ſmall ſolid protuberance, which I imagined to be the rudiments of a glandulous body. The ſurface of the teſticles was ſmooth and uniform, and it was with difficulty I could ſee the lymphatic veſicles, till the membranes which cover the teſticles were removed. The ſmall quantity of liquor that was ſqueezed from the teſticles contained no moving bodies.

EXPER. XXXIII.

In another bitch ſtill younger, there was no appearance of glandulous bodies on the teſticles; their ſurface was white and perfectly ſmooth. Some ſmall veſicles were diſcovered; but they ſeemed to contain no liquor. I compared theſe female teſticles with thoſe of a male of the ſame age, and found that their internal texture, which was fleſhy, was nearly of the ſame nature.

EXPER. XXXIV.

I procured the uterus of a cow that had been recently killed. It was brought to me in a baſket, wrapped in warm cloths, along with a live rabbit, to preſerve it from cooling. The teſticles were as large as a ſmall hen's egg; on one of them was a glandulous body of the ſize of a pea, which protruded from the teſticle like a little nipple: But it had no ſiſſure or external aperture. It was ſo firm and hard, that I could preſs no liquor out of it with my fingers. Before cutting this teſticle, I obſerved two other glandulous bodies at a diſtance from each other. They were very ſmall, and of a whitiſh yellow colour; but the large one, which ſeemed to have pierced the membrane of the teſticle, was as red as a roſe. I examined this laſt with great attention, but could diſcover no liquor; from which I concluded, that it was ſtill far from being mature.

EXPER. XXXV.

In the other teſticle, there were no glandulous bodies which had yet pierced the membrane that covers the teſticle. Two ſmall ones only began to appear under the membrane. I opened them both; but procured no liquor from them. They were hard bodies, with a tincture of yellow.

On each teſticle there were four or five lymphatic veſicles; they were full of liquor. When examined with the microſcope, ſome ſmall globules appeared; but there was not in them the leaſt veſtige of motion. I obſerved this liquor, from time to time, for two days, without diſcovering any thing new.

EXPER. XXXVI.

I had two other uteri conveyed to me in the ſame manner. The one belonged to a young cow that had never brought forth; the other to a cow which, though not old, had had ſeveral young. I firſt examined the teſticles of the latter, and found, upon one of them, a glandulous body as large as a cherry. I perceived three holes into which briſtles might be introduced. Having preſſed the body with my fingers, a ſmall quantity of liquor iſſued out, which I examined, and had the pleaſure of ſeeing moving bodies, [pl. VI. fig. 22.], but different from what I had obſerved in other ſeminal fluids. Theſe globules were ſmall and obſcure: Their progreſſive motion, though diſtinct, was very ſlow. The liquor was not thick: The moving globules had no appearance of threads or tails, and they were not all in motion. Theſe are all the obſervations I could make on this liquor; for, though I again ſqueezed the glandulous body, I could

could not obtain any more liquor that was unmixed with blood. The moving bodies were at leaſt a fourth part leſs than the globules of the blood.

EXPER. XXXVII.

This glandulous body was ſituated at one extremity of the teſticle, near the horn of the uterus; and the liquor which it diſtilled muſt have fallen upon that horn: But, after opening the horn, I found no liquor. I then opened the teſticle longitudinally, and, though its cavity was conſiderable, it contained no fluid. At ſome diſtance from the large glandulous body, there was a ſmall one of the ſame kind, about the ſize of a lentil. Two cicatrices, or little pits, alſo appeared; they were of a deep red colour, and were the relicks of old glandulous bodies which had been obliterated. Having next examined the other teſticle of the ſame cow, I diſcovered four cicatrices and three glandulous bodies; the moſt advanced of which was of a red fleſh-colour, and exceeded not the ſize of a pea. It was ſolid, without any aperture, and contained no liquor. The other two were much ſmaller and harder; and their colour was a kind of orange. The lymphatic veſicles were full of a clear liquid; but contained nothing that had the appearance of life.

EXPER. XXXVIII.

I then inſpected the teſticles of the young cow, which had never brought forth. They were rather larger than thoſe of the other cow; but, what is not leſs remarkable than true, there was not a ſingle cicatrice on either of them. A number of lymphatic veſicles appeared on one of the teſticles; but there was no veſtige of glandulous bodies. Upon the other teſticle, I could diſcern the rudiments of two glandulous bodies, one juſt beginning to ſpring up, the other as large as a ſmall pea. There were alſo many veſicles, which appeared, after being pierced with a lancet, to contain nothing. The glandulous bodies, when opened, gave forth nothing but blood.

EXPER. XXXIX.

I cut each teſticle of both cows into four parts, and, having put them into ſeparate vials, I poured as much water upon them as was juſt ſufficient to cover them; and, after corking the vials cloſe, I allowed them to infuſe for ſix days. I then examined the infuſions with the microſcope, and ſaw an amazing number of moving globules, [pl. VI. fig. 23.]. In all the infuſions, the globules were extremely ſmall, but very active,

active, moving with rapidity round their centres, and in all directions. I obſerved them, from time to time, during three days, and they always became ſmaller and ſmaller, till they totally diſappeared on the third day.

EXPER. XL.

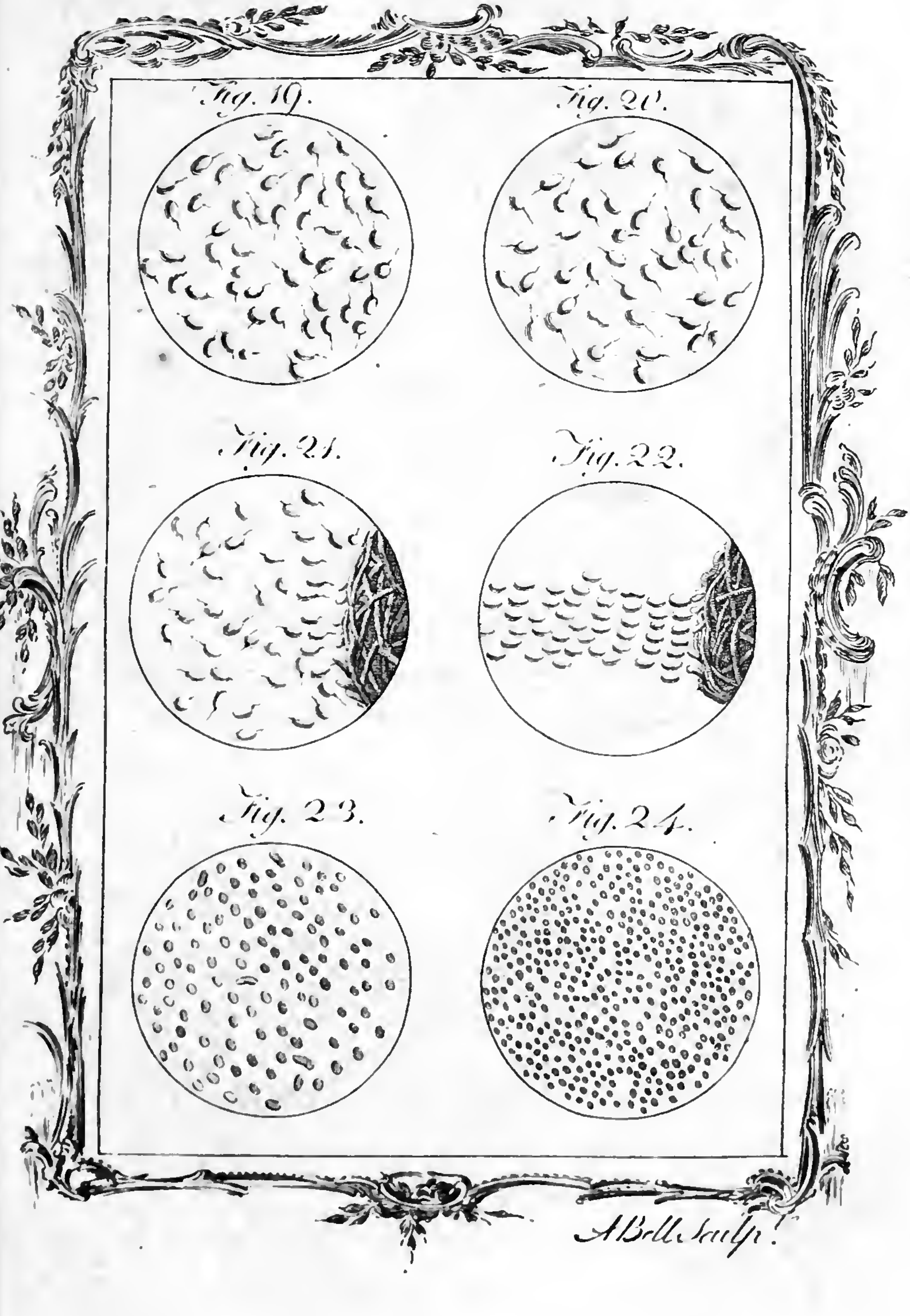
I procured the uteri of three other cows. I firſt ſearched the teſticles, in order to diſcover if there were any mature glandulous bodies. In two of the uteri I found only ſmall glandulous bodies on the teſticles. I was not informed whether the cows had ever brought forth; but it is probable that they had often been in ſeaſon; for a number of cicatrices appeared on their teſticles. On one of the teſticles of the third cow, I obſerved a glandulous body as large as a cherry, and very red; it was much ſwelled, and ſeemed to be perfectly ripe. I preſſed the nipple, which was perforated by a hole, with my fingers, and a conſiderable quantity of liquor iſſued out. In this liquor, I found moving bodies [Pl. VI. fig. 24.] perfectly ſimilar to thoſe deſcribed in Exper. XXXVI. Their number was indeed greater, and their progreſſive motion was quicker; they ſeemed to be ſomewhat longer; and, having obſerved them a long time, I perceived that they grew longer, and changed their figure. I then introduced a fine probe into the ſmall aperture of the glandulous body; and, having cut along the probe as a directory, I found that the cavity was filled with a liquid matter. This liquor, when examined with the microſcope, preſented the ſame phaenomena, the ſame moving bodies, as in Exper. XXXVI. But I could diſcover in none of them either filaments or tails. The liquor of the veſicles was ſtill tranſparent, and contained nothing like life or motion.

EXPER. XLI.

The uteri of ſeveral other cows were brought to me at different times. In the teſticles of ſome of them, there were glandulous bodies almoſt ripe; in thoſe of others, they were in different ſtates of growth; and I perceived nothing new or uncommon, except that I diſcovered, in the teſticles of two of them, glandulous bodies in a decayed ſtate, the baſe of one of which was as large as the circumference of a cherry. The extremity of the nipple was ſoft and withered: The two ſmall holes through which the fluid had iſſued were ſtill viſible. I introduced a ſmall briſtle into them; but there was no liquor either in the canal, or in the internal cavity, which could ſtill be diſtinguiſhed. The extinction of the glandulous bodies, therefore, commences at the moſt external part, or extremity of the nipple. They firſt diminiſh in height, and then

in

Plate VI.



A Bell Sculp.

in breadth, as I had an oportunity of obſerving in another teſticle, where there was a glandulous body diminiſhed about three fourths.

EXPER. XLII.

As the teſticles of female rabbits, as well as their glandulous bodies, are very minute, I could make no exact experiments on their ſeminal liquor. I only diſcovered, that the teſticles of different females are in different ſtates; and that I never ſaw any of them which exactly reſembled De Graaff's figures.

EXPER. XLIII.

On the teſticles of ſome cows, I found a ſpecies of bladders or veſicles, which are called *hydatides* by anatomiſts. I obſerved ſome of them large and others ſmall; and they were attached to the teſticle by a kind of pedicle. I examined the liquor they contained; but it was tranſparent, homogeneous, and every way ſimilar to the liquor in the veſicles. It had no globular or moving particles.

EXPER. XLIV.

At this time, I made ſome experiments upon oyſter-water, upon water in which pepper had been

been boiled, upon water in which pepper had been ſimply infuſed, and upon water in which pink-ſeeds were infuſed. The bottles containing all theſe infuſions were exactly corked. At the end of two days, I ſaw, in the oyſter-water, a vaſt quantity of oval and globular bodies, which ſeemed to ſwim like fiſhes in a pond, and had every appearance of being real animals. They had no members that could be diſcovered, and no tails. They were tranſparent, and pretty large; I ſaw them change their figures; they became gradually ſmaller and ſmaller during the ſeven or eight days that they exiſted; and, laſtly, along with Mr Needham, I ſaw animalcules ſo very ſimilar, in an infuſion of the jelly of roaſted veal, which had likewiſe been cloſe corked, that I am perſuaded they are not true animals, agreeable to the common acceptation of that term, as ſhall afterwards be fully explained.

The infuſion of pink-ſeeds was crowded with innumerable moving globules, which appeared to be equally animated with thoſe in the ſeminal liquors and infuſions of fleſh. At firſt they were pretty large, and moved with great rapidity in every poſſible direction. They continued in this ſtate during three weeks, and gradually diminiſhed in ſize till their minuteneſs rendered them inviſible.

The ſame phaenomenon took place in the infuſions of pepper; but the moving bodies did

not

not appear ſo early as in the other infuſions, and their appearance was later in the infuſion of pepper that was not boiled. I then began to ſuſpect that what is called fermentation, might be owing to the motion of theſe organic particles in animal and vegetable ſubſtances. To diſcover if there was any ſimilarity between this ſpecies of fermentation, and that excited by mineral ſubſtances, I applied to the microſcope a little limeſtone powder, and poured upon it a drop of aquafortis. But the phaenomena were totally different. Large bubbles roſe to the ſurface, and inſtantly darkened the lens of the microſcope; when the groſs parts were diſſolved, every thing remained at reſt, and nothing appeared which had the ſmalleſt analogy to what we perceive in the infuſions of animal or vegetable ſubſtances.

EXPER. XLV.

I examined the ſeminal liquor in the milts of different fiſhes, extracted while the animals were alive; and I obſerved a vaſt quantity of obſcure moving globules. I then ſqueezed with my fingers the aperture in the bellies of fiſhes through which they emit this liquor; and, in the drops which I procured, I ſaw great multitudes of the ſame moving globules, which were almoſt black, and very ſmall.

EXPER.

EXPER. XLVI.

Before I conclude this chapter, I ſhall relate the experiments of Mr Needham upon the ſemen of a ſpecies of cuttle-fiſh, called the *Calmar*. This acute obſerver, having examined the ſpermatic animals in the milts of different fiſhes, found them of an uncommon magnitude in the milt of the calmar. To the naked eye, they were from three to four lines in length. During a whole ſummer, while he diſſected calmars at Liſbon, he could find no appearance of a milt, or of any reſervoir deſtined to receive the ſeminal liquor of that fiſh; and it was the middle of December before he could perceive the firſt veſtiges of a new veſſel filled with a milty juice. This reſervoir, and the juice it contained, gradually increaſed. In examining this ſeminal liquor with the microſcope, he ſaw nothing in it but ſmall opaque globules ſwimming in a kind of ſerous matter, without any appearance of life. But, ſome time after, he diſcovered, in the milt of another calmar, organic bodies completely formed, which reſembled ſpiral ſprings, [*a*, *b*, Pl. VII. fig. 2.] incloſed in a tranſparent caſe. Theſe ſprings were equally perfect at the firſt obſervation as afterwards; only they, in time, contracted themſelves, and formed a kind of ſcrew. The head of the caſe is a ſpecies of valve which

which opens outward, and through which every thing within may be forced out. It contains, besides, another valve, *b*, a little barrel, *c*, and a spongy substance, *d*, *e*. Thus the whole machine consists of an outer, transparent, cartilaginous case, *a*, *fig.* 2. the superior extremity of which is terminated by a round head, formed by the case itself, and performs the office of a valve. This external case contains a transparent tube, which includes the spring, a piston or valve, a little barrel, and a spongy substance. The screw occupies the superior part of the tube and case, the piston and barrel are situated in the middle, and the spongy substance occupies the inferior part. These machines pump the liquor of the milt; the spongy substance is full of this liquor; and, before the animal spawns, the whole milt is only a congeries of these organic bodies, which have absolutely pumped up and dried the milty liquor. Whenever these small machines are taken from the body of the animal, and put among water, or exposed to the air, they begin to act [Pl. VII. fig. 2. and 3.]; the spring mounts up, and is followed by the piston, the barrel, and the spongy substance which contains the liquor: And, as soon as the spring and the tube in which it is contained begin to issue out of the case, the spring plaits, and the whole internal apparatus moves, till the spring, the piston, and the barrel have entirely escaped from the case. When this is effected, all the rest instantly follow, and the

the milty liquor, which had been pumped, and was confined in the ſpongy ſubſtance, runs out through the barrel.

As this phaenomenon is extremely ſingular, and inconteſtibly proves that the moving bodies in the milt of the calmar are not real animals, but ſimple machines, a ſpecies of pumps, I ſhall here tranſcribe Mr Needham's own account of the matter:

'When the ſmall machines *,' ſays he, 'have 'come to their full maturity, ſeveral of them act 'as ſoon as they are expoſed to the air. Moſt 'of them, however, may be commodiouſly 'viewed by the microſcope before their action 'commences; and, even before they act, it is 'neceſſary to moiſten with a drop of water the 'ſuperior extremity of the external caſe, which 'then begins to expand, while the two ſlender 'ligaments that iſſue out of the caſe are twiſted 'and contorted in different ways. At the ſame 'time, the ſcrew riſes ſlowly, and the ſpirals at 'its ſuperior end approach each other, and act 'againſt the top of the caſe, thoſe which are 'lower ſeeming to be continually followed by 'others that iſſue from the piſton; I ſay, that 'they *ſeem* to follow; becauſe I believe it to be 'only a deception produced by the motion of 'the ſcrew. The piſton and barrel likewiſe 'move in the ſame direction; and the inferior

'part,

* Needham's New Diſcoveries made with the Microſcope, ch. 6. p. 53.

'part, which contains the ſemen, extends in 'length, and, at the ſame time, moves towards 'the top of the caſe, which is apparent by the 'vacuity left at the bottom. As ſoon as the 'ſcrew, with the tube in which it is incloſed, 'begins to appear out of the caſe, it twiſts, be-'cauſe it is conſtrained by the two ligaments. 'The whole internal apparatus continues to 'move gradually and ſlowly till the ſcrew, the 'piſton, and the barrel, have entirely eſcaped. 'When that happens, the remainder iſſues in-'ſtantaneouſly. The piſton, *b*, [pl. VII. fig. 2.] 'ſeparates from the barrel *a* ; the ligament, 'which is under the barrel, ſwells and acquires 'a diameter equal to that of the ſpongy part 'which ſucceeds it : This, though much broader 'than when in the caſe, becomes alſo five times 'longer than formerly. The tube, which in-'cluded the whole, contracts in the middle, and 'forms two knots or joints, *d*, *e*, [pl. VII. fig. 2. 'and 3.], diſtant about one third of its length 'from each extremity. Then the ſemen eſcapes 'by the barrel *e*, [fig. 2.]. It is compoſed of 'ſmall opaque globules, which ſwim in a ſerous 'matter, without diſcovering any ſigns of life, 'and are preciſely the ſame as I perceived them 'to be when diffuſed through the reſervoir of 'the milt. In the figure, the part comprehend-'ed between the two joints *d*, *e*, appears to be 'fringed. When examined attentively, this 'appearance ſeems to be occaſioned by the ſpon-

'gy

'gy ſubſtance within the tube being broken and 'divided into portions nearly equal. The following phaenomena will clearly prove that 'this is the caſe.

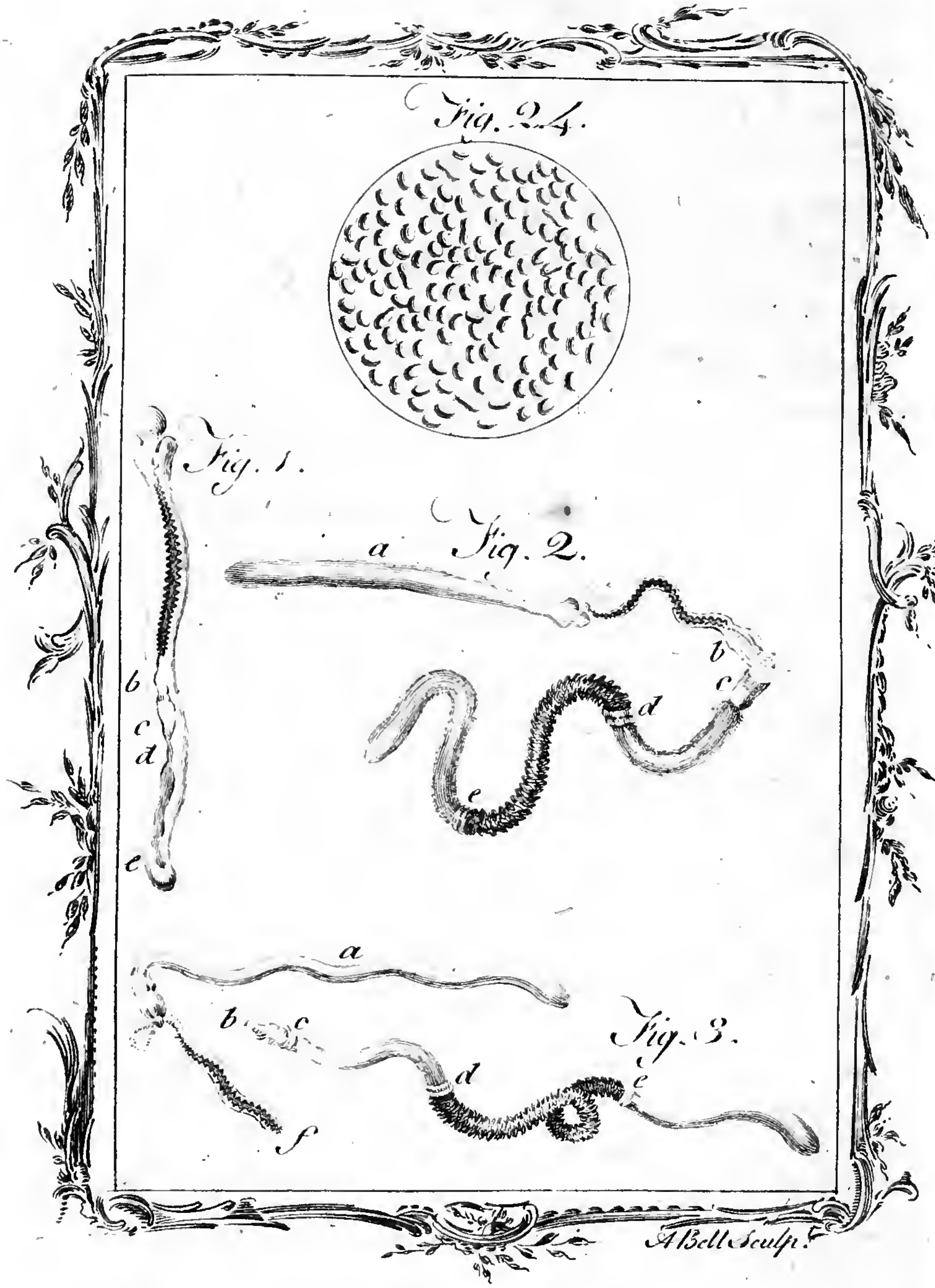
'It ſometimes happens, that the ſcrew and 'the tube break preciſely above the piſton *b*, 'which remains in the barrel *e*, [fig. 3.] Then 'the tube inſtantly ſhuts; and, by contracting, 'aſſumes a conical figure above the extremity of 'the ſcrew, *f*. This is a demonſtration that it 'is there very elaſtic; and the manner in which 'it accommodates its figure to that of the ſubſtance which inculudes it, when the latter undergoes the ſmalleſt change, proves that it is 'every where equally elaſtic.'

M. Needham hence concludes, that it is natural to imagine that the total action of this machine is occaſioned by the ſpring of the ſcrew. But, unfortunately, he proves, by ſeveral experiments, that the ſcrew is acted upon by a power reſiding in the ſpongy part: As ſoon as the ſcrew is ſeparated from the reſt of the machine, it ceaſes to act, and loſes all motion. The author draws the following concluſion from this ſingular phaenomenon.

'If I had ſeen,' ſays he, 'theſe pretended animalcules in the ſemen of living animals, I ſhould, 'perhaps, have been able to aſcertain whether 'they are really animated beings, or only prodigiouſly ſmall machines, which correſpond in 'miniature to the larger veſſels of the calmar.'

From

Plate VII.



From this and other analogies, Mr Needham concludes, that the ſpermatic worms of other animals, it is reaſonable to think, are only organic bodies; a ſpecies of machines ſimilar to thoſe of the calmar, which act at different times; for, ſays he, if we ſuppoſe that, of the prodigious number of ſpermatic animalcules which appear in the field of the microſcope, only a few thouſands act at a time, this will be ſufficient to make us believe the whole to be alive. If it be farther ſuppoſed, he adds, that the motion of each animalcule laſts, like that of the calmar machines, about half a minute; in this caſe, the ſucceſſive action of the ſmall machines would continue for a conſiderable time, and the animalcules would die one after another. Beſides, why ſhould the ſemen of the calmar alone contain machines, while that of all other animals contain real living animalcules? Here the analogy is ſo ſtrong as to be almoſt irreſiſtible. Mr Needham farther remarks, that even Leeuwenhoek's experiments ſeem to indicate that the ſpermatic animals have a great reſemblance to the organic bodies in the ſemen of the calmar. Speaking of the ſemen of the cod, Leeuwenhoek remarks, that he imagined the oval bodies to be animalcules burſt and diſtended, becauſe they were four times larger than when alive. And, in another place, he obſerves of the ſemen of a dog, that the animalcules often changed their

their figure, eſpecially when the liquor began to evaporate *.

On all theſe accounts, Mr Needham conjectured, that the pretended ſpermatic animals were only a kind of natural machines, bodies much more ſimply organized than thoſe of real animals. I examined the machines of the calmar along with him, and the reader may be aſſured that his deſcription of them is both exact and faithful. His experiments, therefore, demonſtrate, that the ſeminal fluid conſiſts of particles in queſt of organization; that, in fact, it produces organized bodies; but that theſe bodies are not animals, nor ſimilar to the individual which produces them. It is indeed, probable, that theſe organized bodies are only a kind of inſtruments for perfecting the ſemen, and beſtowing on it an active force; and that it is by their internal action that they intimately penetrate the ſeminal fluid of the female.

CHAP.

* See Leeuwenh. Arc. nat. p. 306. 309. and 319.

CHAP. VII.

Comparifon of my own Experiments with thofe of Leeuwenhoek.

THOUGH my experiments were made with all the attention of which I was capable, and though I often repeated them, I am fatisfied that many things muft have efcaped me. I have defcribed only what I faw, and what every man may fee, at the expence of a little art and patience. To free myfelf from prejudice, I even attempted to forget what other obfervers pretended to have feen, endeavouring, by this means, to be certain of feeing nothing but what really appeared; and it was not till I had digefted my experiments, that I wifhed to compare them with thofe of former writers, and particularly with thofe of Leeuwenhoek, who had occupied himfelf more than 60 years in experiments of this kind.

Whatever authority may be due to this acute obferver, it is certainly allowable to inftitute a comparifon between a man's own obfervations, and thofe of the moft refpectable writer on the fame fubject. By an examination of this kind, truth may be eſtabliſhed, and errors may be detected, eſpecially when the only object of inquiry is to aſcertain the genuine nature of thoſe moving bodies which appear in the ſeminal fluids of all animals.

In the month of November 1677, Leeuwenhoek, who had formerly communicated many microſcopic obſervations to the Royal Society of London, concerning the juices of plants, the texture of trees, the optic nerve, rain water, &c. writes to Lord Brouncker, preſident of the Society, in the following terms: 'Poſtquam * Exc. 'Dominus Profeſſor Cranen me viſitatione ſua 'ſaepius honorarat, litteris rogavis Domino Ham 'cognato ſuo, quaſdam obſervationum mearum 'videndas darem. Hic Dominus Ham me ſe'cundo inviſens, ſecum in laguncula vitrea ſemen 'viri, gonorrhoea laborantis, ſponte deſtillatum, 'attulit, dicens, ſe poſt pauciſſimas temporis mi'nutas (cum materia illa jam in tantum eſſet 'reſoluta ut fiſtulae vitreae immitti poſſet) ani'malcula viva in eo obſervaſſe, quae caudam et 'ultra 24 horas non viventia judicabat: Idem 'referebat ſe animalcula obſervaſſe mortua poſt 'ſumptam ab aegroto therebintinam. Materi'am praedicatam fiſtulae vitreae immiſſam, prae'ſente Domino Ham, obſervavi, quaſdamque in 'ea creaturas viventes, ac poſt decurſum 2 aut 3 'horarum eamdem ſolus materiam obſervans, 'mortuas vidi.

'Eamdem

* See Phil. Tranſ. No. 141. p. 1041.

'Eamdem materiam (ſemen virile) non ae-
'groti alicujus, non diuturna conſervatione cor-
'ruptam, vel poſt aliquot momenta fluidiorem
'factam, ſed ſani viri ſtatim poſt ejectionem, ne
'interlabentibus quidem ſex arteriae pulſibus,
'ſaepiuſcule obſervavi, tantamque in ea viven-
'tium animalculorum multitudinem vidi, ut in-
'terdum plura quam 1000 in magnitudine a-
'renae ſeſe moverent; non in toto ſemine, ſed
'in materia fluida craſſiori adhaerente, ingen-
'tem illam animalculorum multitudinem obſer-
'vavi; in craſſiori vero ſeminis materia quaſi
'ſine motu jacebant, quod inde provenire mihi
'imaginabar, quod materia illa craſſa ex tam va-
'riis cohaereat partibus, ut animalcula in ea ſe
'movere nequirent; minora globulis ſanguini
'ruborem adferentibus haec animalcula erant,
'ut judicem, millena millia arenam grandiorem
'magnitudine non aequatura. Corpora eorum
'rotunda, anteriora obtuſa, poſteriora ferme in
'aculeum deſinentia habebant; cauda tenui lon-
'gitudine corpus quinquies ſexieſve excedente,
'et pellucida, craſſitiem vero ad 25 partem cor-
'poris habente, praedita erant, adeo ut ea quo
'ad figuram cum cyclaminis minoribus, longam
'caudam habentibus, optime comparare queam:
'Motu caudae ſerpentino, aut ut anguillae in
'aqua natantis, progrediebantur; in materia vero
'aliquantulum craſſiori caudam octies decieſve
'quidem evibrabant antequam latitudinem capilli
'procedebant. Interdum imaginabar me inter-

N 2 'noſcere

'noscere posse adhuc varias in corpore horum 'animalculorum partes, quia vero continuo eas 'videre nequibam, de iis tacebo. His animal-'culis minora adhuc animalcula, quibus non nisi 'globuli figuram attribuere possum, permista 'erant.

'Memini me, ante tres aut quatuor annos, ro-'gatu Domini Oldenburg B. M. semen verile ob-'servasse, et praedicta animalia pro globulis ha-'buisse; sed quia fastidiebam ab ulteriori inqui-'sitione, et magis quidem a descriptione, tunc 'temporis eam omisi. Jam quoad partes ipsas, 'ex quibus crassam seminis materiam, quoad 'majorem sui partem consistere saepius cum ad-'miratione observavi, ea sunt tam varia ac multa 'vasa, imo in tanta multitudine haec vasa vidi, 'ut credam me in unica seminis gutta plura ob-'servasse quam anatomico per integrum diem 'subjectum aliquod secanti occurrant. Quibus 'visis, firmiter credebam nulla in corpore hu-'mano jam formato esse vasa, quae in semine 'virili bene constituto non reperiantur. Cum 'materia haec per momenta quaedam aëri fuisset 'exposita, praedicta vasorum multitudo in aquo-'sam magnis oleaginosis globulis permistam ma-'teriam mutabatur,' &c.

The secretary of the Royal Society replied to this letter of Leeuwenhoek, that it would be proper to make similar experiments on the seminal fluids of other animals, not only to support the orginal discovery, but to distinguish whatever differences might appear in the number and figure

figure of the animalcules: And, with regard to the vafcular texture of the thick part of the feminal fluid, he fufpected that it was only a congeries of filaments, without any regular organization: 'Quae tibi videbatur vaforum congeries, 'fortaffis feminis funt quaedam filamenta, haud 'organice conftructa, fed dum permearunt vafa 'generationi infervientia in iftiufmodi figuram 'elongata. Non diffimili modo ac faepius no-'tatus fum falivam craffiorem ex glandularum 'faucium foraminibus editam, quafi e convolutis 'fibrillis conftantem *.'

Leeuwenhoek replied, 18th March 1678, in the following words: 'Si quando canes cocunt 'marem a foemina ftatim feponas, materia quae-'dam tenuis et aquofa (lympha fcilicet fperma-'tica) a pene folet paulatim exftillare; hanc 'materiam numerofiffimis animalculis repletam 'aliquoties vidi, eorum magnitudine quae in 'femine virili confpiciuntur, quibus particulae 'globulares aliquot quinquagies majores per-'mifcebantur.

'Quod ad vaforum in craffiori feminis virilis 'portione fpectabilium obfervationem attinet, 'denuo non femel iteratam, faltem mihimetipfi 'comprobaffe videor; meque omnino perfuafum 'habeo, cuniculi, canis, felis, arterias venafve 'fuiffe a peritiffimo anatomico haud unquam 'magis perfpicue obfervatas, quam mihi vafa in 'femini virili, ope perfpicilli, in confpectum 'venere.

* See Phil. Tranf. No. 141. p. 1043.

'Cum mihi praedicta vafa primum innotuere, 'ftatim etiam pituitam, tum et falivam perfpi-'cillo applicavi; verum hic minime exiftentia 'animalia fruftra quaefivi.

'A cuniculorum coitu lymphae fpermaticae 'guttulam unam et alteram, e femella extillan-'tem, examini fubjeci, ubi animalia praedicto-'rum fimilia, fed longe pauciora, comparuere. 'Globuli item quam plurimi, plerique magnitu-'dine animalium, iifdem permifti funt.

'Horum animalium aliquot etiam delinea-'tiones tranfmifi; figura, 1. [pl. VI. fig. 1.] ex-'primit corum aliquot vivum (in femine cuni-'culi arbitror) eaque forma qua videbatur, dum 'afpicientem me verfus tendit. A B C, capitu-'lum cum trunco indicant; C D, ejufdem cau-'dam, quam pariter ut fuam anguilla inter na-'tandum vibrat. Horum millena millia, quan-'tum conjectare eft, arenulae majoris molem vix 'fuperant. [Pl. VI. fig. 2. 3. 4.] funt ejufdem 'generis animalia, fed jam emortua.

'[Pl. VI. fig. 5.] delineatur vivum animalcu-'lum quemadmodum in femine canino fefe ali-'quoties mihi attentius intuenti exhibuit. E F G, 'caput cum trunco indigitant, G H, ejufdem 'caudam. [Pl. VI. fig. 6. 7. 8.] Alia funt in 'femine canino quae motu et vita privantur, 'qualium etiam vivorum numerum adeo in-'gentem vidi, ut judicarem portionem lymphae 'fpermaticae arenulae mediocri refpondentem, 'eorum ut minimum decena millia continere.'

In

In another letter to the Royal Society, dated May 31. 1678, Leeuwenhoek adds, 'Seminis 'canini tantillum microſcopio applicatum iterum 'contemplatus ſum, in eoque antea deſcripta 'animalia numeroſiſſime conſpexi. Aqua plu'vialis pari quantitate adjecta, iiſdem confeſtim 'mortem accercit. Ejuſdem ſeminis canini por'tiuncula in vitreo tubulo unciae partem duo'decimalem craſſo ſervata, ſex et triginta hora'rum ſpatio contenta animalia vita deſtituta ple'raque, reliqua moribunda videbantur.

'Quo de vaſorum in ſemine genitali exiſten'tia magis conſtaret, delineationem aliqualem 'mitto, ut in figura A B C D E [pl. VI. fig. 9.] 'quibus literis circumſcriptum ſpatium arenulam 'mediocrem vix ſuperat.'

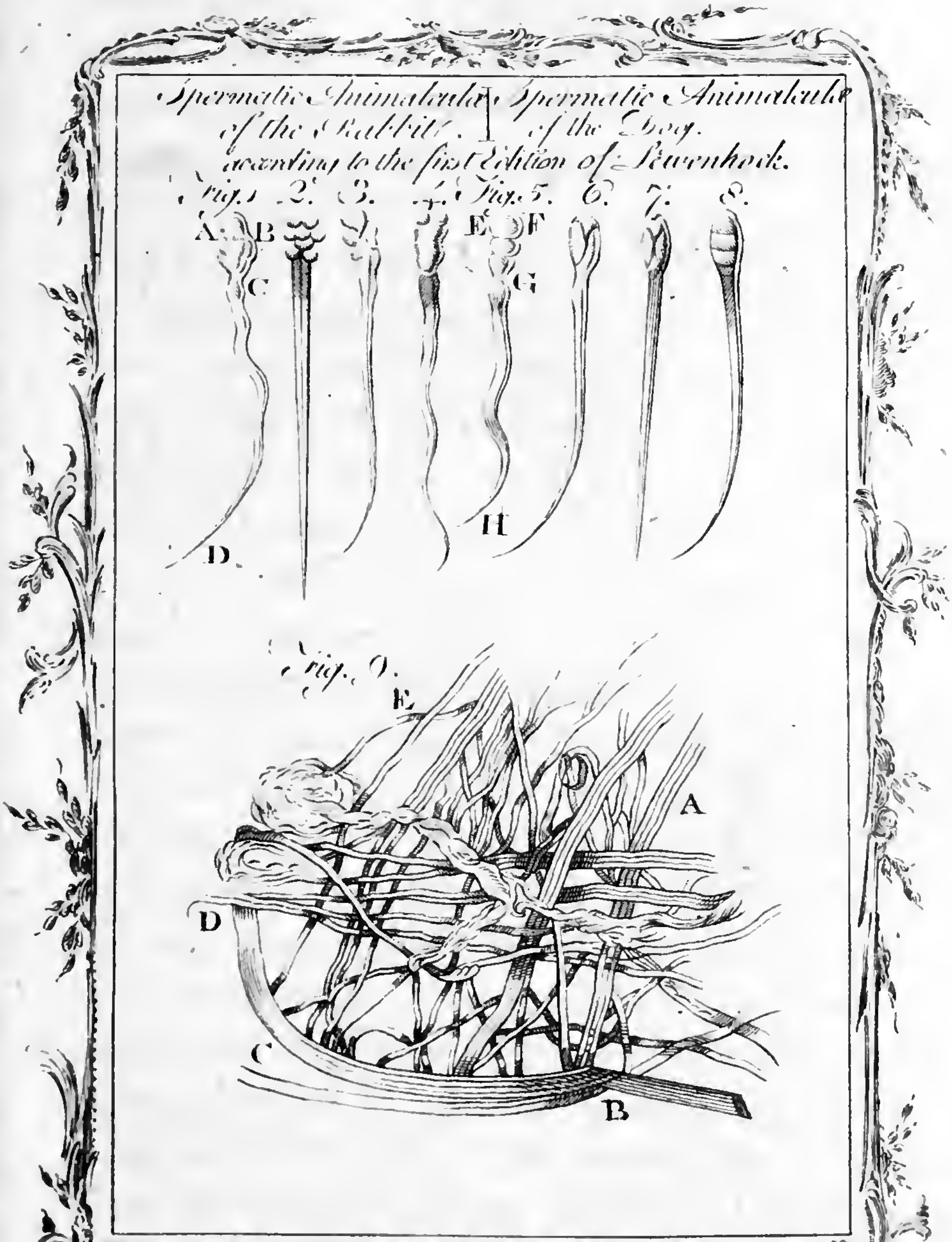
I have tranſcribed theſe paſſages from the Philoſophical Tranſactions, becauſe they firſt appeared in that work, before Leeuwenhoek had formed any theory; and, therefore, they muſt be more agreeable to truth. After the ingenious author had formed a ſyſtem of generation, his account of the ſpermatic animals varies, even in eſſential articles *.

In the firſt place, what he ſays concerning the number of theſe pretended animalcules is true; but the figure of their bodies correſponds not always to his deſcription. Sometimes the end next

* Here the author attempts a formal proof that Leeuwenhoek invented the ſingle microſcope, and diſcovered the exiſtence of ſpermatic animals, before Hartſoecker, which interrupts the argument, is nowiſe intereſting to the reader, and therefore I have here omitted it in the tranſlation.

next the tail is globular, and sometimes cylindrical; sometimes it is flat, and at other times it is broader than long, &c. With regard to the tail, it is often thicker and shorter than he represents. The vibratory motion he ascribes to the tail, and by which he alledges the animals are enabled to proceed forward, I never could distinguish in the manner he describes. I have seen these moving bodies vibrate eight or ten times, from right to left, or from left to right, without advancing the breadth of a single hair; and I have observed many of them which never could proceed forward, because this tail, in place of assisting them to swim, was, on the contrary, a small thread attached to the filaments or mucilaginous part of the liquor, and, of course, totally prevented the progressive motion of the body. Even when the tail appeared to have any motion, it resembled only the small bendings of a thread at the end of a vibration. I have seen these threads or tails fixed to the filaments, which Leeuwenhoek calls vessels: I have seen them separate from the filaments, after repeated efforts made by the moving bodies: I have seen them first long, then diminish, and at last disappear. Thus these tails ought to be regarded as accidental appendages, and not as real members of the moving bodies. But, what is more remarkable, Leeuwenhoek expressly affirms, in his letter to Lord Brouncker, that, besides the tailed animals, he observed in this liquor animalcules still more minute that had no tails, and were perfectly

Plate VIII.



A Bell Sculp.

perfectly globular: 'His animalculis (caudatis 'ſcilicet) minora adhuc animalcula, quibus non 'niſi globuli figuram attribuere poſſum, per-'miſta erant.' This is the truth. After Leeuwenhoek, however, had maintained that theſe animalcules were the only efficient principle of generation, and that they were transformed into men, he regards as real animals thoſe only which had tails; and, accordingly, as it was neceſſary that animalcules, to be transformed into men, ſhould have a conſtant and invariable figure, he never afterwards mentions the round animals without tails. I was ſtruck with the difference between the original compoſition of this letter, and the form in which it appeared twenty years afterwards in his third volume: For, inſtead of the words which we have juſt now quoted, we meet with the following in pag. 63. 'Animalculis hiſce permiſtae jacebant 'aliae minutiores particulae, quibus non aliam 'quam globulorum ſeu ſphaericam figuram aſ-'ſignare queo.' This is a very different account of the matter. A particle of matter, to which he aſcribes no motion, is extremely different from an animalcule. It is aſtoniſhing that Leeuwenhoek, in copying his own letter, ſhould have changed an article of ſo much conſequence. What he immediately ſubjoins likewiſe merits attention. He ſays, that, at the intreaty of Mr Oldenburg, he had examined this liquor three or four years ago; and that he then imagined theſe animalcules to be globules. Thus, theſe pretended

pretended animalcules are ſometimes globules without any ſenſible motion; ſometimes they are globules which move with great activity; ſometimes they have tails, and ſometimes no tails. Speaking of ſpermatic animals in general, he remarks *, 'Ex hiſce meis obſervationibus cogitare 'coepi, quamvis antehac, de animalculis in ſeminibus maſculinis agens, ſcripſerim me in illis 'caudas non detexiſſe, fieri tamen poſſe ut illa 'animalcula aeque caudis fuerint inſtructa, ac 'nunc comperi de animalculis in gallorum gal-'linaceorum ſemine maſculino:' Another proof that he has often ſeen ſpermatic animals of all kinds, without tails.

Secondly, It is worthy of remark, that Leeuwenhoek had very early diſcovered the filaments which appear in the ſemen before it be liquified; and that, at that time, when he had not conceived his hypotheſis concerning the ſpermatic animals, he imagined the filaments to be veins, nerves, and arteries. He firmly believed, that all the parts and veſſels of the human body might be clearly diſtinguiſhed in the ſeminal fluid. He even perſiſted in this opinion, notwithſtanding the repreſentations made to him by Mr Oldenburg, in name of the Royal Society. But, after he conceived the notion of transforming his ſpermatic animals into men, he never again takes any notice of theſe veſſels. Inſtead of regarding them as the nerves and blood-veſ-ſels

* Tom. 3. p. 371.

ſels of the human body already formed in the ſemen, he does not even aſcribe to them their real function, which is the production of the moving bodies. He obſerves *, 'Quid fiet de 'omnibus illis particulis ſeu corpuſculis praeter 'illa animalcula ſemini virili hominum inhae-'rentibus! Olim et priuſquam haec ſcriberem, 'in ea ſententia fui praedictas ſtrias vel vaſa ex 'teſticulis principium ſecum ducere,' &c. And, in another place, he ſays, that what he had formerly remarked concerning veſſels in the ſemen deſerved no attention.

Thirdly, If we compare the figures 1. 2. 3. and 4. Pl. VIII. IX. which we have repreſented exactly as they appear in the Philoſophical Tranſactions, with thoſe which Leeuwenhoek cauſed to be engraved ſeveral years after, we ſhall find very great differences, eſpecially in thoſe of the dead animalcules of the rabbit, 1. 3. and 4. and in thoſe of the dog, which I have alſo delineated, in order to give a diſtinct idea of the matter. From all this, it may fairly be concluded, that Leeuwenhoek has not always ſeen the ſame phaenomena; that the moving bodies, which he regards as animals, have appeared to him under different forms; and that he has contradicted himſelf with a view to make the ſpecies of men and of animals uniform and conſiſtent. He not only varies as to the fundamental part of theſe experiments, but alſo as to the manner of making

* Tom. 1. p. 7.

king them; for he expreſsly tells us, that he always diluted the ſemen with water, to ſeparate its parts, and to give more freedom of motion to the animalcules *; and yet, in his firſt letter to Lord Brouncker, he ſays, that, when he mixed the ſemen of dogs, in which he before had ſeen innumerable animals, with water, they all inſtantly died. Thus Leeuwenhoek's firſt experiments were made, like mine, without any mixture; and it appears, that he was not in uſe to mix the liquor with water till long after he began his experiments, and till he conceived the idea that water killed the animalcules; which, however, is not true: I imagine that the addition of water only diſſolves the filaments too ſuddenly; for, in all my experiments, I have ſeen but very few filaments in the liquor, after its being mixed with water.

Leeuwenhoek was no ſooner perſuaded that the ſpermatic animalcules were transformed into men and other animals, than he imagined that he ſaw two diſtinct kinds in the ſemen of every animal, the one male, and the other female. Without this difference of ſex in the ſpermatic animalcules, it was difficult, he ſays, to conceive the poſſibility of producing males and females by ſimple transformation. He mentions theſe male and female animalcules in his letter publiſhed in the philoſophical Tranſactions, No. 145. and in ſeveral other places †. But he attempts not to deſcribe

* Tom. 3. p. 92. 93.

† See tom. 1. p. 163. and tom. 3. p. 101. of his works.

describe the differences between the male and female animalcules, which never existed but in his own imagination.

The famous Boerhaave having asked Leeuwenhoek, whether he had observed any differences in the growth and size of spermatic animals? Leeuwenhoek replied, that, in the semen of a rabbit which he had opened, he saw an infinite number of animalcules: 'Incredibilem,' says he, 'viventium animalculorum numerum 'conspexerunt, cum haec animalcula scypho 'imposita vitreo et illic emortua, in rariores or- 'dines disparassent, et per continuos aliquot dies 'saepius visu examinassem, quaedam ad justam 'magnitudinem nondum excrevisse adverti. Ad 'haec quasdam observavi particulas perexiles et 'oblongas, alias aliis majores, et, quantum ocu- 'lis apparebat, cauda destitutas; quas quidem 'particulas non nisi animalcula esse credidi, quae 'ad justam magnitudinem non excrevissent *.' Here we have animalcules of different sizes, and some with tails, and others that had no tails, which better correspond with my experiments than with Leeuwenhoek's system. We only differ in a single article. He considers the oblong bodies without tails as young animalcules which have not yet arrived at their full growth: But I, on the contrary, have seen these pretended animals originally spring from the filaments with their tails or threads, which they gradually lost.

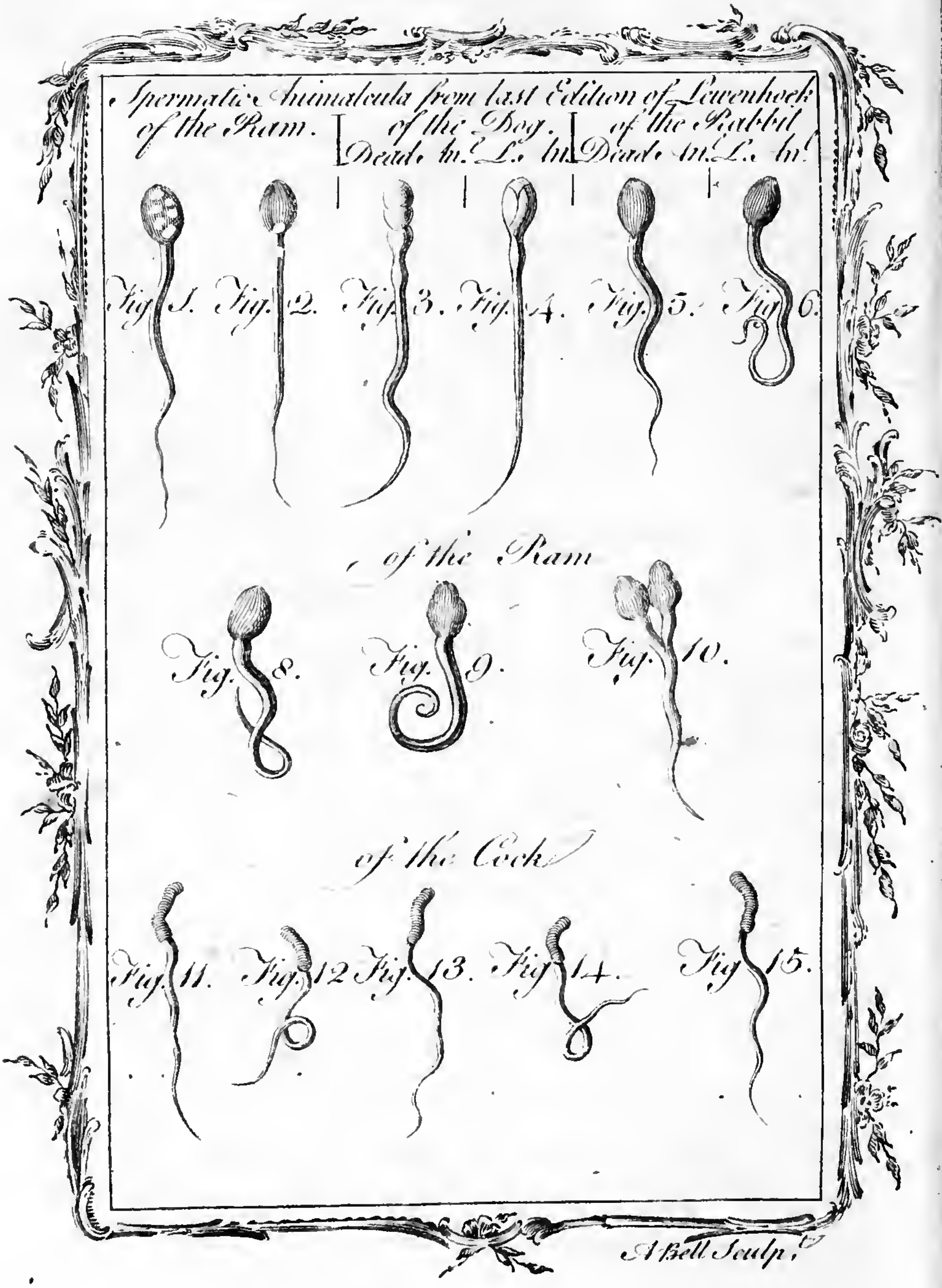
In

* See tom. 4. p. 280. 281.

In the ſame letter to Boerhaave he ſays *, that, in the ſemen of a ram he obſerved the animalcules marching in flocks like ſheep: 'A tribus 'circiter annis teſtes arietis, adhuc calentes, ad 'aedes meas deferri curaveram; cum igitur ma'teriam ex epididymibus eductam, ope micro'ſcopii contemplarer, non ſine ingente voluptate 'advertebam animalcula omnia, quotquot inna'tabant ſemini maſculino, eundem natando cur'ſum tenere, ita nimirum ut quo itinere priora 'praenatarent, eodem poſteriora ſubſequerenter, 'adeo ut hiſce animalculis quaſi ſit ingenitum, 'quod oves factitare videmus, ſcilicet ut praece'dentium veſtigiis grex univerſus incedat.' This obſervation, made by Leeuwenhoek in the 1713, and which he regarded as new and ſingular, is a ſufficient proof that he had never ſo attentively examined the ſeminal fluids of animals as to enable him to give exact deſcriptions of them. In the 1713, he was 71 years of age: He had been in the conſtant practice of making experiments with the microſcope for 45 years: He continued to publiſh his obſervations during 36 years: And yet, after all this practice, he now, for the firſt time, obſerved a phaenomenon which is exhibited in every ſemen, and which I have deſcribed, Exper. IX. in the human ſemen, Exper. XII. in the ſemen of a dog, and Exper. XXIX. in the ſemen of a bitch. To explain the moving of the animalcules of the ram in flocks, therefore,

* Tom. 4. 28.

Plate. IX.



Spermatic Animalcula from last Edition of Lewenhoek
of the Ram.
of the Dog.
Dead. in. L. in.
of the Rabbit
Dead. in. L. in.
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
of the Ram
Fig. 8.
Fig. 9.
Fig. 10.
of the Cock
Fig. 11.
Fig. 12
Fig. 13.
Fig. 14.
Fig. 15.
A Bell Sculp.

therefore, it is unneceſſary to ſuppoſe them endowed with the natural inſtinct peculiar to ſheep; ſince thoſe of man, of the dog, and of the bitch, move in the very ſame manner; and ſince this motion depends upon particular circumſtances, the principal of which is, that the fluid part of the ſemen ſhould be on one ſide, and the thick or filamentous part on the other; for then the whole moving bodies diſengage themſelves from the filaments, and proceed, in the ſame direction, into the more fluid part of the liquor.

In another letter, written the ſame year, and addreſſed to Boerhaave *, he relates ſome farther obſervations concerning the ſemen of the ram: He tells us, that, when the liquor was put into ſeparate glaſſes and examined, he obſerved flocks of animalcules moving all in the ſame direction, and other flocks returning the contrary way. He adds: 'Neque illud in unica epididymum 'parte, ſed et in aliis quas preciderain partibus, 'obſervavi. Ad haec, in quadam paraſtatarum 'reſecta portione complura vidi animalcula, quae 'necdum in juſtam magnitudinem adoleverant; 'nam et corpuſcula illis exiliora et caudae triplo 'breviores erant quam adultis. Ad haec, caudas 'non habebant deſinentes in mucronem, quales 'tamen adultis eſſe paſſim comperio. Praeterea, 'in quandam paraſtatarum portionem incidi, a-'nimalculis, quantum diſcernere potui, deſtitu-'tam, tantum illi quaedam perexiguae inerant 'particulae,

* See tom. 4. p. 304.

'particulae, partim longiores partim breviores; 'ſed altera ſui extremitate craſſiunculae; iſtas 'particulas in animalcula tranſituras eſſe non du- 'bitabam.' From this paſſage, it is apparent that Leeuwenhoek had ſeen in this ſeminal liquor, what I have found in the ſemen of all the animals which I examined, moving bodies that differed in ſize, figure, and motion; and theſe circumſtances, it is obvious, correſpond better with the notion of organic particles in motion, than with that of real animals.

It appears, therefore, that Leeuwenhoek's obſervations, though he draws very different concluſions from them, perfectly correſpond with mine: And, though there be ſome oppoſition in the facts, I am fully perſuaded, that, whoever ſhall take the trouble of repeating the experiments, will eaſily diſcover the ſource of theſe differences, and find that I have related nothing but truth. To enable the reader to decide in this matter, I ſhall add a few remarks.

We do not always ſee, in the human ſemen, the filaments I have mentioned: For this purpoſe, the liquor muſt be examined the moment it is extracted from the body; and even then they do not uniformly appear. When the liquor is too thick, it preſents nothing but large globules, which may be diſtinguiſhed with a common lens. When examined with the microſcope they have the appearance of ſmall oranges; they are very opaque, and one of them occupies

cupies the whole field of the microſcope. The firſt time I obſerved theſe globules, I imagined them to be foreign bodies which had fallen into the liquor. But, after examining different drops, I found that the whole liquor was compoſed of theſe large globules. I obſerved one of the largeſt and roundeſt of them for a long time. At firſt it was perfectly opaque: A little after, I perceived on its ſurface, about half way between the centre and circumference, a beautiful coloured luminous ring, which continued more than half an hour, then gradually approached the centre, which became clear and coloured, while the reſt of the globule remained opaque. This light, which illuminated the centre, reſembled that which appears in large air-bubbles. The globule now began to grow flat, and to have a ſmall degree of tranſparency: And, after obſerving it for three hours, I could perceive no other change, no appearance of motion, either internal or external. I imagined that ſome change might happen by mixing the liquor with water. The globules were indeed changed into a tranſparent homogeneous fluid, which preſented nothing worthy of remark. I left the ſemen to liquify of its own accord, and examined it at the diſtance of 6, 12, and 24 hours; but found nothing like life or motion. I relate this experiment to ſhow, that the ordinary phaenomena are not always to be expected in ſeminal fluids, though they be apparently ſimilar.

Sometimes all the moving bodies have tails, eſpecially in the ſemen of man, and of the dog; their motion is not then very rapid, and appears to be performed with difficulty. If the liquor be allowed to dry, the tails or threads are firſt deprived of motion; the anterior extremity continues to vibrate for ſome time, and then all motion ceaſes. Theſe bodies may be long preſerved in this ſtate; and, if a ſmall drop of water be then poured upon them, their figure changes; they fall down into ſeveral minute globules, which appear to have a ſmall degree of motion, ſometimes approaching each other, and ſometimes trembling, and turning round their centres.

The moving bodies in the human ſemen, and in thoſe of the dog and bitch, reſemble each other ſo ſtrongly, that it is not eaſy to diſtinguiſh them, eſpecially when examined immediately after they are taken from the body of the animal. Thoſe of the rabbit appear to be ſmaller and more active. But theſe differences and reſemblances proceed more from the different ſtates of the fluids during the time of examination, than from the nature of the fluids themſelves, which ought indeed to be different in different ſpecies of animals: For example, in the human fluid, I have remarked large filaments, as repreſented in pl. III. fig. 3. &c. and I have ſeen the moving bodies ſeparate from theſe filaments, from which they appeared to derive their origin. But I could perceive nothing of this kind in the ſemen

ſemen of the dog. Inſtead of diſtinct filaments, it is generally compoſed of a compact mucilage, in which we with difficulty perceive ſome filamentous parts; and yet this mucilage gives birth to moving bodies ſimilar to thoſe in the human ſemen.

The motion of theſe bodies continues longer in the fluid of the dog, than in that of man, which enables us more eaſily to diſtinguiſh the change of form above remarked. The moment the fluid iſſues from the body of the animal, we find moſt of the animalcules poſſeſſed of tails. In 12, 24, or 36 hours afterwards, almoſt the whole tails diſappear; we then perceive only oval bodies moving about, and generally with more rapidity than at firſt.

The moving bodies are always below the ſurface of the liquor. Several large tranſparent air-bubbles commonly appear on the ſurface: but they have no motion, unleſs when the liquor is agitated. Below the moving bodies we often perceive others ſtill more minute: Theſe have no tails; but moſt of them move: And, in general, I have remarked, that, of the numberleſs globules in all theſe liquors, the ſmalleſt are generally blacker and more obſcure than the others; and that thoſe which are extremely minute and tranſparent have little or no motion. They ſeem likewiſe to have more ſpecific gravity; for they are always ſunk deepeſt in the fluid.

CHAP. VIII.

Reflections on the preceding Experiments.

FROM the foregoing experiments, it appears, that females, as well as males, have a feminal fluid containing bodies in motion; that these moving bodies are not real animals, but only organic living particles; and that these particles exist not only in the feminal fluids of both sexes, but in the flesh of animals, and in the seeds of vegetables. To discover whether all the parts of animals and all the seeds of plants contained moving organic particles, I made infusions of the flesh of different animals, and of the seeds of more than twenty different species of vegetables; and, after remaining some days in close glasses, I had the pleasure of seeing organic moving particles in all of them. In some they appeared sooner, in others later. Some preserved their motion for months, and others soon ceased to move. Some, at first, produced large moving globules, resembling animals, which changed their figure, split, and became gradually smaller. Others produced only small globules whose motions were extremely rapid; and others produced

ced filaments, which grew longer, ſeemed to vegetate, and then ſwelled, and poured out torrents of moving globules. But it is needleſs to give a detail of my experiments on the infuſions of plants, eſpecially ſince Mr Needham has publiſhed his excellent and numerous obſervations on this ſubject. To this able naturaliſt I have read over the preceding treatiſe; I have often reaſoned with him on the reſemblance between the moving bodies in infuſions of the ſeeds of vegetables, and thoſe in the ſeminal fluids of male and female animals. He thought my views well founded, and of ſufficient importance to merit a farther diſcuſſion. He, therefore, began to make experiments on the different parts of vegetables; and I acknowledge, that he has brought the ideas I communicated to greater perfection than I could have done. Of this I could give many examples: But I ſhall confine myſelf to one, becauſe I formerly pointed out the fact in queſtion, which he deſcribes in the following manner.

To aſcertain whether the moving bodies which appear in infuſions of fleſh were real animals, or only, as I had imagined, organic moving particles, Mr Needham thought that an examination of the jelly of roaſted meat would determine the queſtion; becauſe, if they were animals, the fire would deſtroy them, and, if not, they would ſtill be perceptible, in the ſame manner as when the fleſh was raw. Having, for this purpoſe, taken the jellies of veal and of other kinds of roasted meat, he put them in glaſſes filled with water, and carefully corked the bottles. After ſome days infuſion, he found in the whole of the liquors an immenſe number of moving bodies. He ſhowed me ſeveral of theſe infuſions, and, among others, that of the veal jelly, which contained moving bodies very ſimilar to thoſe in the ſemen of man, the dog, and the bitch, after they had loſt their tails or threads. Though they changed their forms, their motions were ſo ſimilar to thoſe of animals ſwimming, that, whoever ſaw them for the firſt time, or had been ignorant of what has been formerly remarked concerning them, would certainly have conceived them to be real animals. I ſhall only add, that Mr Needham has eſtabliſhed, by numberleſs experiments, the exiſtence of moving organic particles in all the parts of vegetables, which confirms what I have alledged, and extends my theory concerning the compoſition and reproduction of organized beings.

It is apparent, then, that all animals, whether male or female, and every ſpecies of vegetable, are compoſed of living organic particles. Theſe organic particles abound moſt in the ſeminal fluids of animals, and in the ſeeds of vegetables. Reproduction is effected by the union of theſe organic particles, which are detached from all parts of the animal or vegetable body, and are always ſimilar to the particular ſpecies to which they

they belong; for their union could not be accomplished but by the intervention of an internal mould, which is the efficient cause of the figure of the animal or vegetable, and in which the essence, the unity, and the continuation of the species consists, and will invariably continue till the end of time.

But, before drawing general conclusions from the system I have established, some objections must be removed, which will contribute still farther to illustrate the subject.

It will be demanded of me, why I deny these moving bodies to be animals, after they have uniformly been recognized as such by every man who has examined them? It may likewise be asked, How is it possible to conceive the nature of living organic particles, unless we allow them to be real animals? And to suppose an animal to be composed of lesser animals, is nearly the same idea, as when we say that an organized body is composed of organic living particles. To these questions I shall endeavour to give satisfactory answers.

It is true, that almost all observers agree in regarding the moving bodies in the seminal fluid as real animals. But it is equally certain, both from my experiments, and those of Mr Needham upon the semen of the calmar, that these moving bodies are beings more simple, and less organized than animals.

The

The word *animal*, in its common acceptation, reprefents a general idea, compofed of particular ideas which we derive from particular animals. All general ideas include many different ideas, which more or lefs approach or recede from one another; and, of courfe, no general idea can be precife or exact. The general idea we have formed of an animal, may be derived from the particular idea of a dog, of a horfe, and of other animals, from the power of volition, which enables them to act according to their inclination, and from the circumftances of their being compofed of flefh and blood, from their faculty of choofing and of taking nourifhment, from their fenfes, from the diftinction of fexes, and from their power of reproducing. The general idea, therefore, expreffed by the word *animal*, includes a number of particular ideas, not one of which conftitutes the effence of the general idea: For there are animals which have no intelligence, no will, no progreffive motion, no flefh or blood, and appear to be only a mafs of congealed mucilage: There are others which cannot feek for their food, and only receive it from the element in which they exift; others have no fenfes, not even that of feeling, at leaft in a perceptible degree. Some have no fexes, or have both in one individual. There remains nothing, therefore, in the properties of an animal, but the power of reproduction, which is common to both the vegetable and animal. It is from the whole

whole taken together that a general idea muſt be formed; and, as this whole is compoſed of different parts, there muſt of neceſſity be degrees or intervals between theſe parts. An inſect, in this ſenſe, is leſs an animal than a dog, an oyſter than an inſect, and a ſea-nettle, or a freſh water polypus, than an oyſter: And, as Nature proceeds by inſenſible degrees, we ſhould find beings partaking of ſtill leſs animation than a ſea-nettle or a polypus. Our general ideas are only artificial methods of collecting a number of objects under one point of view; and they have, like other artificial methods, the defect of not being able to comprehend the whole. They are in direct oppoſition to the procedure of Nature, which is uniform, inſenſible, and always particular. It is to graſp a number of particular ideas under one word, of which we have no clearer notion than that word conveys; becauſe, when the word is once received, we imagine it to be a line drawn between the different productions of nature; that every thing above this line is an *animal*, and every thing below it a *vegetable*, which is another word equally general, and employed as a line of ſeparation between organized bodies and brute matter. But, as has already been remarked, theſe lines of ſeparation have no exiſtence in nature. There are bodies which are neither animals, vegetables, nor minerals; and every attempt to arrange them under either of theſe claſſes muſt be ineffectual.

For

For example, Mr Trembly, when he firſt examined the freſh water polypus, ſpent much time before he could determine whether it was an animal or a vegetable. The reaſon is plain; this polypus is perhaps neither the one nor the other; and all that can be ſaid is, that it has moſt reſemblance to an animal: And, as we are inclined to think, that every organized being is either an animal or a plant, we believe not the exiſtence of any organized body, unleſs it falls under ſome of theſe general denominations, although there muſt be, and in fact there are, many beings which belong neither to the one nor the other. The moving bodies found in the ſeminal fluids, and in infuſions of the fleſh of animals, as well as in thoſe of all parts of vegetables, are of this ſpecies: We can neither rank them under animals nor vegetables; and no man in his ſenſes will ever maintain them to be minerals.

We may, therefore, pronounce, without heſitation, that the great diviſion of natural productions into *animals*, *vegetables*, and *minerals*, comprehends not all material beings; ſince beings exiſt which can be included in none of theſe claſſes. Nature paſſes, by imperceptible ſteps, from the animal to the vegetable; but, from the vegetable to the mineral, the paſſage is ſudden, and the interval great. Here the law of imperceptible degrees ſuffers a violation. This circumſtance made me ſuſpect, that, by examining

ning Nature more closely, we should find intermediate organized beings, which, without having the faculty of reproduction, like animals and vegetables, would still enjoy a species of life and motion; beings which, without having the properties either of animals or vegetables, might enter into the constitution of both; and, lastly, beings which would consist of the first assemblages of the organic particles mentioned in the preceding chapters.

Eggs constitute the first class of this species of beings. Those of hens and other female birds are attached to a common pedicle, and derive their nourishment and growth from the body of the animal. But, when attached to the ovarium, they are not properly eggs; they are only yellow globes, which separate from the ovarium as soon as they acquire a certain magnitude: Such is their internal organization, however, that they absorb nourishment from the lymph contained in the uterus, and convert it into the white, membranes, and shell. Thus the egg possesses a species of life and organization. It grows and assumes a form by its own peculiar powers: It neither lives like an animal, nor vegetates like a plant, nor enjoys the faculty of reproduction. The egg, therefore, is a distinct being, which can neither be ranked with the animal nor mineral kingdoms. If it be alledged that the egg is only an animal production destined for the nourishment of the chick, and ought to be regarded

garded as a part of the hen; I reply, that eggs, whether impregnated or not, are always organized in the ſame manner; that impregnation changes only a part which is almoſt inviſible; that it grows, and acquires a uniform figure and ſtructure, both externally and internally, independent of impregnation; and, conſequently, it ought to be conſidered as a ſeparate and diſtinct being.

This will be ſtill more apparent, if we attend to the growth and formation of the eggs of fiſhes. When the female depoſits them in the water, they are properly but the rudiments of eggs, which, being lately ſeparated from the body of the animal, attract and aſſimilate thoſe particles that are fitted for their nouriſhment; and thus increaſe in ſize by mere abſorption. In the ſame manner as the egg of the hen acquires its white and membranes while floating in the uterus, the eggs of fiſhes acquire their white and membranes in the water; and, whether they are fecundated by the male's ſhedding his milt upon them, or they remain unimpregnated, they ſtill arrive at full perfection. It is plain, therefore, that eggs in general ought to be regarded as organized bodies, and as forming a diſtinct genus from animals and vegetables.

The organized bodies found in the ſemen of all animals, and which, like thoſe in the milt of the calmar, are natural machines, and not animals, form a ſecond ſpecies of the ſame genus.

They

They are properly the firſt aſſemblages of thoſe organic particles ſo often mentioned; and, perhaps, they are the conſtituent particles of all animated bodies. They appear in the ſemen of every animal, becauſe the ſemen is only the reſidue of the organic particles which the animal takes in with its food. The particles, as formerly remarked, aſſimilated from the food, are thoſe which are moſt organized, and moſt analogous to the animal itſelf: It is of theſe particles that the ſemen conſiſts; and, of courſe, we ought not to be ſurpriſed to find organized bodies in that fluid.

To be ſatisfied that theſe organized bodies are not real animals, we have only to reflect upon the preceding experiments. The moving bodies in the ſemen have been conſidered as real animals, becauſe they have a progreſſive motion, and ſomething ſimilar to tails. But, after attending, on the one hand, to the nature of this motion, which is ſuddenly finiſhed, and never again commences, and, on the other, to the nature of the tails, which are only threads adhering to the moving body, we will begin to heſitate; for an animal goes ſometimes ſlow, and ſometimes faſt; and it ſometimes ſtops, and repoſes, without moving at all. Theſe moving bodies, on the contrary, go always in the ſame direction at the ſame time; I never ſaw them ſtop and again begin to move; and, if they once ſtop, it is for ever. I demand, if this continued motion, with-

out

out any repoſe, is common to animals; and if, from this circumſtance, we ought not to doubt concerning the real animation of theſe moving bodies? An animal ſhould always have a uniform figure, as well as diſtinct members: But theſe moving bodies change their figure every moment; they have no diſtinct members; and there tails are only adventitious matter, and no part of the individual. How, then, can they be eſteemed real animals? In ſeminal liquors, we ſee filaments which ſtretch out, and ſeem to vegetate; then they ſwell and produce moving bodies. Theſe filaments are, perhaps, of a vegetable nature; but the moving bodies which proceed from them cannot be animals; for we have no example of vegetables giving birth to animals. Moving bodies are found in all animal and vegetable ſubſtances promiſcuouſly. They are not the produce of generation. They have no uniformity of ſpecies. They cannot, therefore, be either animals or vegetables. As they are to be met with in every part of animals and of vegetables, but are moſt abundant in their ſeeds, is it not natural to regard them as the organic living particles of which animals and vegetables are compoſed, as particles which, being endowed with motion, and a ſpecies of life, ought to produce, by their union, moving and living beings, and, in this manner, form animals and vegetables?

But,

But, to remove every doubt upon this ſubject, let us attend to the obſervations of others. Can the active machines diſcovered by Mr Needham in the milt of the calmar be regarded as animals? Can we believe that eggs, which are active machines of another ſpecies, are alſo animals? If we examine Leeuwenhoek's repreſentations of the moving bodies found in many different ſubſtances, will we not be ſatisfied, at the firſt inſpection, that they are not animals, ſince none of them have any members, but are uniformly either round or oval? If we attend to what this famous obſerver has remarked concerning the motion of theſe pretended animals, we muſt be convinced that he was wrong in regarding them as real animals, and we will be more and more confirmed in the opinion, that they are only organic moving particles. We ſhall give ſome examples. Leeuwenhoek * gives the figure of the moving bodies in the ſeminal fluid of a male frog. This figure repreſents nothing but a thin, long body, pointed at one of the extremities. Let us attend to what he ſays concerning it: 'Uno tempore caput (that is, the largeſt extremity of the moving body) craſſius mihi 'apparebat alio; plerumque agnoſcebam animalculum haud ulterius quam a capite ad 'medium corpus, ob caudae tenuitatem, et cum 'idem animalculum paulo vehementius move'retur (quod tamen tarde fiebat) quaſi volumine 'quodam

* Tom. 1. p. 51.

'quodam circa caput ferebatur. Corpus fere 'carebat motu, cauda tamen in tres quatuorve 'flexus volvebatur.' Here we have the change of ſigure that I had obſerved, the mucilage from which the moving bodies with difficulty diſengage themſelves, the ſlowneſs of their motion before they eſcape from the mucilage, and, laſtly, a part of the pretended animal in motion while the other is dead; for, a little afterwards, he obſerves, 'movebant poſteriorem ſolum partem, quae ultima morti vicinia eſſe 'judicabam.' All this is repugnant to the nature of an animal, but exactly correſponds with my experiments, except that I never ſaw the tail move, but in conſequence of an agitation of the body. Speaking of the ſeminal fluid of the cod, he ſays *, 'Non eſt putandum omnia animalcula in ſemine aſelli contenta uno eodemque tempore vivere, ſed illa potius tantum vivere quae exitui ſeu partui viciniora ſunt, quae 'et copioſiori humido innatant prae reliquis vita 'carentibus, adhuc in craſſa materia, quam humor eorum efficit, jacentibus.' If theſe are animals, why were they not all alive? Why did thoſe only live which were in the moſt fluid part of the liquor? Leeuwenhoek did not obſerve, that the thick part, inſtead of being a humour produced by the animalcules, is a mucilage, which gives birth to them. If he had diluted the mucilage with water, he would at once have given

* P. 52.

given life and motion to the whole. The mucilage itſelf is often nothing elſe than a maſs of thoſe bodies, which begin to move as ſoon as they can diſengage themſelves; and, of courſe, this thick matter or mucilage, inſtead of being a humour produced by the animalcules, is only a congeries of the animals themſelves, or rather, as formerly remarked, the matter of which they are formed. Speaking of the ſemen of the cock, Leeuwenhoek, in his letter to Grew, ſays *, ‘ Contemplando materiam (ſeminalem) animad‘verti ibidem tantam abundantiam viventium ‘ animalium, ut ea ſtuperem; forma ſeu externa ‘ figura ſua noſtrates anguillas fluviatiles refere‘bant, vehementiſſima agitatione movebantur; ‘ quibus tamen ſubſtrati videbantur multi et ad‘modum exiles globuli, item multae plan-ova‘les figurae, quibus etiam vita poſſet attribui, ‘ et quidem propter earumdem commotiones; ‘ ſed exiſtimabam omnes haſce commotiones et ‘ agitationes provenire ab animalculis, ſicque ‘ etiam res ſe habebat; attamen ego non opi‘nione ſolum, ſed etiam ad veritatem mihi per‘ſuadeo has particulas, planam et ovalem figu‘ram habentes, eſſe quaedam animalcula inter ‘ ſe ordine ſuo diſpoſita et mixta, vitaque adhuc ‘ carentia.’ Here we have animalcules, in the ſame ſeminal fluid, of different forms; and I am convinced, from my own experiments, that, if Leeuwenhoek had obſerved thoſe oval bodies

* Page 5.

with attention, he would have perceived that they moved with their own proper force, and, conſequently, that they were as much alive as the others. This change of figure, it is true, exactly correſponds with what I had obſerved: But it does not indicate a uniform ſpecies of animals; for, in the preſent example, if the bodies having the figure of a ſerpent were genuine ſpermatic animalcules, each of which was deſtined to become a cock, and therefore implies a uniform and invariable organization, what was the end and deſtination of thoſe of an oval figure? He, indeed, afterwards remarks, that theſe oval bodies might be the ſame with the ſerpentine, if we ſuppoſe them rolled up in a ſpiral manner. But ſtill, how is it poſſible to conceive that an animal, with its body in this reſtrained poſture, ſhould be able to move without extending itſelf? I, therefore, maintain, that theſe oval bodies were only the organic particles ſeparated from their threads or tails, and that the ſerpentine bodies were the ſame particles, which had not yet been deprived of theſe appendages, as I have often remarked in other ſeminal fluids.

Beſides, Leeuwenhoek, who believed all theſe moving bodies to be real animals, who eſtabliſhed a ſyſtem upon that foundation, and who affirmed that ſpermatic animalcules were tranſformed into men and other animals, now ſuſpected them to be only natural machines, or moving organic particles. He never entertained a doubt,

but

but that these animalcules contained the large animal in miniature. He remarks *, ‘ Progeneratio animalis ex animalculo in seminibus masculinis omni exceptione major est ; nam, etiamsi in animalculo ex semine masculo, unde ortum est, figuram animalis conspicere nequeamus, attamen satis superque certi esse possumus figuram animalis ex qua animal ortum est, in animalculo, quod in semine masculo reperitur, conclusam jacere sive esse : Et quanquam mihi saepius, conspectis animalculis in semine masculo animalis, imaginatus fuerim me posse dicere, en ibi caput, en ibi humeros, en ibi femora ; attamen cum ne minima quidem certitudine de iis judicium ferre potuerim, hucusque certi quid statuere supersedeo, donec tale animal, cujus semina mascula tam magna erunt, ut in iis figuram creaturae ex qua provenit agnoscere queam, invenire secunda nobis concedat fortuna.’ This opportunity, so much desired by Leeuwenhoek, happily occurred to Mr Needham. The spermatic animals of the calmar are three or four lines in length, and are visible without the assistance of the microscope. Their whole parts and organization are easily perceived. But they are by no means small calmars, as Leeuwenhoek imagined. They are not even animated, though they have motion, but are only machines, which

* Pag. 67.

ought to be regarded as the firſt union of the organic particles.

Though Leeuwenhoek had not this opportunity of undeceiving himſelf, he had, however, obſerved other appearances which ought to have produced this effect. He had remarked, for example, that the ſpermatic animals of the dog * often changed their figure, eſpecially when the fluid was nearly evaporated ; that, when dead, they had an opening in the head, which did not appear when they were alive ; and that the head was full and round, during the life of the pretended animal, and flat and ſunk after its death : Theſe circumſtances ſhould have led him to heſitate concerning the real animation of theſe bodies, and to think that the phaenomena correſponded more with a machine which emptied itſelf, like that of the calmar, than with the properties of an animal.

I have ſaid that the motion of theſe moving bodies, theſe organic particles, is not ſimilar to the motion of animals, and that there is no intervals in their movements. Leeuwenhoek, in tom. 1. p. 168. makes preciſely the ſame remark ; 'Quotieſcunque,' ſays he, 'animalcula in ſemine maſculo animalium fuerim contemplatus, attamen illa ſe unquam ad quietem contuliſſe, me nunquam vidiſſe, mihi dicendum eſt, ſi modo ſat fluidae ſupereſſet materiae in qua ſeſe commode movere poterant ; at eadem in con-' tinuo

* See tom. 1. p. 160.

'tinuo manent motu, et, tempore quo ipſis mori-
'endum appropinquante, motus magis magiſque
'deficit, uſquedum nullus prorſus motus in illis
'agnoſcendus ſit.' It is difficult to conceive, that animals ſhould exiſt, which, from the moment of their birth to their diſſolution, ſhould continue to move rapidly, without the ſmalleſt interval of repoſe; or to imagine that the ſpermatic animals of the dog, which Leeuwenhoek perceived to be as active on the ſeventh day as the moment they proceeded from the body of the dog, ſhould be able, during all this time, to move with a celerity which no animal on earth could perſiſt in for a ſingle hour, eſpecially when the reſiſtence ariſing from the denſity and tenacity of the fluid is taken into conſideration. This ſpecies of continued motion, on the contrary, has an exact correſpondence to the nature of the organic particles, which, like artificial machines, produce their effects by a continued operation, and ſtop immediately afterwards.

In the numerous experiments made by Leeuwenhoek, he doubtleſs obſerved ſpermatic animals without tails. He even mentions them in ſome places, and endeavours to explain the phaenomenon. For example, ſpeaking of the ſemen of the cod, he ſays *, 'Ubi vero ad lactium ac-
'cederem obſervationem, in iis partibus quas a-
'nimalcula eſſe cenſebam, neque vitam neque
'caudam

* Tom 2. p. 150.

'caudam dignoſcere potui; cujus rei rationem 'eſſe exiſtimabam, quod quamdiu animalcula 'natando loca ſua perfecte mutare non poſſunt, 'tamdiu etiam cauda concinne circa corpus ma-'neat ordinata, quodque ideo ſingula animalcula 'rotundum repraeſentent corpuſculum.' It would have been more ſimple, and more agreeable to truth, to have ſaid, that the ſpermatic animals of this fiſh ſometimes have tails, and ſometimes have none, than to ſuppoſe that the tails were ſo exactly wound round their bodies as to give them a ſpherical figure. One would be apt to think, that Leeuwenhoek had never fixed his eyes upon, or deſcribed any moving particles but thoſe which had tails; he has given figures of none that wanted tails, becauſe, though they moved, he did not regard them as animals. This is the reaſon why all Leeuwenhoek's figures of ſpermatic animals are very ſimilar, and all drawn with tails. When they appeared in any other form, he thought they were imperfect, or rather that they were dead. Beſides, it is apparent from my experiments, that, inſtead of unfolding their tails, wherever they are placed in circumſtances proper for ſwimming, as Leeuwenhoek inſiſts, theſe pretended animals gradually loſe their tails, in proportion to the rapidity of their motions, till, at laſt, theſe tails, which are bodies foreign to the animalcules, or threads which they drag after them, totally diſappear.

Leeuwenhoek, ſpeaking of the ſpermatic animals of man *, ſays: 'Aliquando etiam animadverti inter animalcula particulas quaſdam 'minores et ſubrotundas; cum vero ſe ea aliquoties eo modo oculis meis exhibuerint, ut mihi 'imaginarer eas exiguis inſtructas eſſe caudis, 'cogitare coepi annon hae forte particulae forent animalcula recens nata; certum enim mihi 'eſt ea etiam animalcula per generationem provenire, vel ex mole minuſcula ad adultam procedere quantitatem: Et quis ſcit annon ea 'animalcula, ubi moriuntur, aliorum animalculorum nutritioni atque augmini inſerviant!' It appears from this paſſage, that Leeuwenhoek had ſeen, in the human ſemen, animalcules without tails; and that he is obliged to ſuppoſe them to be recently produced, which is directly the reverſe of what I have obſerved; for the moving bodies are never larger than when they ſeparate from the filaments, which is the period when their motion begins: But, as ſoon as they are fully diſengaged from the mucilage, they become ſmaller, and continue to diminiſh till their motion entirely ceaſes. With regard to the generation of theſe animals, which Leeuwenhoek imagines to be certain, no veſtige of copulation has been diſcerned by the moſt acute obſervers. It is purely a random aſſertion, as may be eaſily proved from his own experiments. He remarks, for example, with

* Tom. 3. p. 93.

with great propriety, that the milt of the cod * is gradually filled with ſeminal liquor ; and that, after the fiſh has ſpent this liquor, the milt dries, and leaves only a flaccid membrane, entirely deſtitute of every kind of fluid. ‘ Eo tempore,’ ſays he, ‘ quo aſellos major lactes ſuos emiſit, rugae ‘ illae, ſeu tortiles lactium partes, uſque adeo con‘ trahuntur, ut nihil praeter pelliculas ſeu membra‘ nas eſſe videantur.’ How ſhould this dry membrane, which contains neither ſeminal liquor nor animalcules, produce animalcules of the ſame ſpecies next ſeaſon ? If they were produced by a regular generation, ſuch a long interruption could not take place, which, in moſt fiſhes, continues a whole year. To remove this difficulty, he afterwards remarks : ‘ Neceſſario ſtatuendum erit, ‘ ut aſellus major ſemen ſuum emiſerit, in lacti‘ bus etiamnum multum materiae ſeminalis gig‘ nendis animalculis aptae remanſiſſe, ex qua ma‘ teria plura oportet provenire animalcula ſemi‘ nalia quam anno proxime elapſo emiſſa fuerant.’ This ſuppoſition, that part of the ſeminal liquor remains in the milt for the production of ſpermatic animals the following year, is perfectly gratuitous, and contrary to obſervation ; for the milt, during this interval, is nothing but a thin dry membrane. But how will he explain a phaenomenon that takes place in ſome fiſhes, and particularly in the calmar, whoſe ſeminal liquors are not only renewed every year, but even the membranes

* Tom. 3. p. 98.

membranes which contain them? Here neither the milt nor the ſeminal liquor are preſerved till the ſucceeding year; and, of courſe, their regular reproduction cannot be aſcribed to generation. It is, therefore, apparent, that theſe pretended ſpermatic animals are not multiplied, like other animals, by generation; and this circumſtance alone would entitle us to conclude, that the moving particles in the ſeminal fluid are not real animals. Leeuwenhoek, though he tells us, in the paſſage above quoted, that the ſpermatic animals are certainly propagated by generation, acknowledges, however, in another place *, that the manner in which theſe ſpermatic animals are produced, is exceedingly obſcure, and that he leaves to others the farther elucidation of this ſubject. 'Perſuadebam mihi,' ſays he, ſpeaking of the ſpermatic animals of the dormouſe, 'haecce 'animalcula ovibus prognaſci, quia diverſa in 'orbem jacentia et in ſemet convoluta videbam; 'ſed unde, quaeſo, primam illorum originem de-'rivabimus! an animo noſtro concipiemus ho-'rum animalculorum ſemen jam procreatum 'eſſe in ipſa generatione, hocque ſemen tam diu 'in teſticulis hominum haerere, uſquedum ad 'annum aetatis decimum-quartum vel decimum-'quintum aut ſextum pervenerint, eademque 'animalcula tum demum vita donari, vel in 'juſtam ſtaturam excreviſſe, illoque temporis 'articulo generandi maturitatem adeſſe! ſed haec 'lampada

* Tom. 1. p. 26.

'lampada aliis trado.' It is, perhaps, unnecessary to make many remarks on what Leeuwenhoek has here advanced. He saw, in the semen of the dormouse, spermatic animals which were round and without tails; *in semet convoluta*, says he, because he always supposes that they ought to have tails. He was formerly certain that these animals were propagated by generation: Here he seems to be convinced of the reverse. But, when he learned, that the vine-fretters *(pucerons)* were propagated without copulation *, he laid hold of this idea, in order to explain the generation of spermatic animals. 'Quemadmodum,' says he, 'animalcula haec 'quae pediculorum antea nomine designavimus '(the pucerons) dum adhuc in utero materno 'latent, jam praedita sunt materia seminali ex 'qua ejusdem generis proditura sunt animalcula, 'pari ratione cogitare licet animalcula in seminibus masculinis ex animalium testiculis non 'migrare, seu ejici, quin post se relinquant minuta animalcula, aut saltem materiam seminalem ex qua iterum alia ejusdem generis animalcula proventura sunt, idque absque coitu, 'eadem ratione qua supradicta animalcula generari observavimus.' This supposition is not more satisfactory than the preceding; for, by thus comparing the generation of spermatic animalcules with that of the vine-fretter, we discover not the reason why they are never seen in the

* See tom. 2. p. 499. et tom. 3. p. 271.

the human ſemen till the age of 14 or 15; nor do we learn whence they proceed, or how they are yearly renewed in fiſhes, &c. Notwithſtanding all the efforts of Leeuwenhoek to eſtabliſh the generation of ſpermatic animals, he leaves the ſubject in the greateſt obſcurity, where it probably would have for ever remained, if we had not diſcovered, by the preceding experiments, that they are not animals, but organic moving particles, contained originally in the food, and found in vaſt numbers in the ſeminal liquors of animals, which are the moſt pure and moſt organic extracts derived from the food.

Leeuwenhoek acknowledges, that he did not always find animalcules in the male ſemen; for example, in that of the cock, which he often examined, he never but once ſaw the eel-like animalcules: And, ſome years after, he could not diſcover theſe eels *, but found animalcules with a large head and a tail, which his drawer could not perceive. He likewiſe remarks, that, during one ſeaſon, he could not diſcover living animals in the ſeminal fluid of the cod †. All theſe diſappointments proceeded from this circumſtance, that, though he ſaw moving globules, he was unwilling to acknowledge them to be animals, unleſs they had tails, though it is in the form of globules that they moſt generally appear, either in ſeminal fluids, or in infuſions of

* See tom. 3. p. 370.
† Tom. 3. p. 306.

of animal and vegetable ſubſtances. In the ſame place, he remarks, that, though he he had often diſtinctly ſeen the ſpermatic animals of the cod, he was never able to make his drawer perceive them: 'Non ſolum,' ſays he, 'ob eximiam eorum exilitatem, ſed etiam quod eorum corpora adeo eſſent fragilia, ut corpuſcula paſſim dirumperenter; unde factum fuit ut nonniſi raro, nec ſine attentiſſima obſervatione, animadverterem particulas planas atque ovorum in morem longas, in quibus ex parte caudas dignoſcere licebat; particulas has oviformes exiſtimavi animalcula eſſe dirupta, quod particulae hae diruptae quadruplo fere viderentur majores corporibus animalculorum vivorum.' When an animal, whatever be its ſpecies, dies, it does not ſuddenly change its form; from being long like a thread, it does not become round like a bullet; neither does it become four times as large after as before death. Not a ſingle article of what is advanced by Leeuwenhoek, in this paſſage, has the ſmalleſt correſpondence to the nature of an animal; but, on the contrary, the whole agrees with a ſpecies of machines which, like thoſe of the calmar, burſt and empty themſelves, after having performed their functions. To purſue this obſervation a little further: He tells us, that he has ſeen the ſpermatic animals of the cod under different forms, 'Multa apparebant animalcula ſphaeram pellucidam repraeſentantia,' and of different ſizes, 'Haec

'animalcula

'animalcula minori videbantur mole, quam ubi 'eadem antehac in tubo vitreo rotundo exami-'naveram.' This is an evident proof, that there is nothing like a uniform and invariable ſpecies in theſe animalcules, and conſequently, that they are not animals, but only organic moving particles, which, by their different combinations, aſſume various figures and ſizes. Of theſe organic particles, vaſt numbers appear in the extract and in the reſidue of our food. The matter which adheres to the teeth, and which, in healthy perſons, has the ſame ſmell with the ſeminal fluid, is only a reſidue of our food. In it we accordingly find a great quantity of theſe pretended animals, ſome of which have tails, and reſemble thoſe of the ſeminal fluid. Mr Baker has given figures of four ſpecies of them, which are all a kind of cylinders, ovals, or globules, ſome of them having tails, and others not. But, after the ſtricteſt examination, I am perſuaded, that none of them are real animals, and that they are only, like thoſe in the ſemen, the organic living particles of the food appearing under different forms. Leeuwenhoek, who knew not how to account for theſe pretended animals in the matter adhering to the teeth, ſuppoſes them to proceed from certain ſpecies of food, as cheeſe, in which they previouſly exiſted; but they are found among the teeth of every perſon, whatever kind of food be eaten; and, beſides, they have no reſemblance to mites,

or

or other animalcules which appear in corrupted cheeſe. In another place, he tells us that theſe teeth-animals proceed from the ciſtern-water which we drink, becauſe he obſerved ſimilar animals in rain-water, eſpecially when it had ſtagnated upon leaden roofs. But, when we give the hiſtory of microſcopic animals, we ſhall demonſtrate, that moſt of thoſe found in rain-water are only organic moving particles, which divide, unite, change their ſize and figure, and, in a word, which can be made to move or to reſt, to live or die, as often as we pleaſe.

Moſt ſeminal fluids ſpontaneouſly dilute, or become more liquid, when expoſed to the air or to a certain degree of cold, than when they iſſue from the body. But they thicken upon the application of a moderate degree of heat. I expoſed ſome of theſe fluids to a degree of cold equal to that of water juſt beginning to freeze; but the pretended animalcules ſuffered not the leaſt injury from it. They moved with equal activity, and during the ſame length of time, as thoſe to which no cold had been applied. But thoſe which were expoſed to a ſmall degree of heat, ſoon ceaſed to move, becauſe the liquor thickened. If theſe moving bodies were animals, they differed in their nature and conſtitution from all others, to which a moderate degree of heat communicates force and motion, and upon whoſe bodies cold has the very oppoſite effects.

Before leaving this ſubject, upon which I have, perhaps, dwelt too long, I muſt ſtill add another remark, which may lead to ſome uſeful concluſions. Theſe pretended ſpermatic animals, which are nothing but the organic living particles of food, exiſt, not only in the ſeminal fluids of both ſexes, and in the remnants of food that adhere to the teeth, but likewiſe in the chyle and in the excrements. Leeuwenhoek, having met with them in the excrements of frogs, and of other animals which he diſſected, was at firſt greatly ſurpriſed; and, not being able to conjecture from whence animals could proceed ſo ſimilar to thoſe in the ſeminal liquor he had juſt been examining, he accuſes his own want of dexterity, and ſuppoſes, that, in diſſecting the animal, he had inadvertently opened the ſeminal veſſels, and that the ſemen had in this manner been mixed with the faeces. But, having afterwards obſerved the ſame phaenomenon in the faeces of other animals, and even in his own, he was then totally nonpluſſed. It is worthy of remark, that Leeuwenhoek never found animalcules in his own faeces, but when they were liquid. Whenever his ſtomach was out of order, and his belly was looſe, the animalcules appeared; but, when his food was properly concocted, and his faeces were hard, not a ſingle animalcule was to be found, although he diluted the faeces with water. Theſe facts ſeem perfectly to coincide

with

with what we formerly advanced; for, when the ſtomach and inteſtines properly perform their functions, the faeces are only the groſs dregs of the aliment, and all the nouriſhing and organic particles are abſorbed by the lacteal veſſels: In this caſe we cannot expect to find organic particles in the faeces, which are ſolely compoſed of the uſeleſs and inert part of our food. But, when the ſtomach and inteſtines, from any indiſpoſition, allow the food to paſs without being properly digeſted, then the organic particles mix with the faeces; and, when examined with the microſcope, we diſcover them in the form of living organic bodies. Hence we may conclude, that people who are troubled with looſeneſs ſhould have leſs ſeminal liquor, and be leſs fitted for the purpoſes of generation, than thoſe of a contrary habit of body.

I have all along ſuppoſed that the female furniſhes a fluid equally neceſſary to generation as that of the male. In the firſt chapter, I endeavoured to prove, that every organized body contains living organic particles; and, in Chap. II. and III. that nutrition and reproduction are effects of the ſame cauſe; that nutrition is performed by abſorption, or an intimate penetration of organic particles through all parts of the body; and that reproduction is effected by the ſuperplus of theſe ſame organic particles, collected from every part of the body, and depoſited in reſervoirs deſtined for that purpoſe. In

Chap.

Chap. IV. I have ſhown how this theory applies to the generation of man, and other animals which have different ſexes. Females being organized bodies, as well as males, they muſt alſo have ſome reſervoirs for the reception of the ſurplus of organic particles returned from all parts of their bodies. This ſurplus, as it is extracted from every part of the body, muſt appear in the form of a fluid; and it is this fluid to which I have given the appellation of the Female ſemen.

This fluid is not inert, as Ariſtotle pretends, but prolific, and equally eſſential to generation as the ſemen of the male. It contains particles diſtinctive of the female ſex, as that of the other ſex contains particles proper for the conſtitution of male organs; and both of them contain all the other organic particles which may be regarded as common to the two ſexes: And hence, from a mixture of the two, the ſon may reſemble his mother, and the daughter her father. Hippocrates maintains, that the ſemen conſiſts of two fluids, one ſtrong, which produces males, and the other weak, which produces females. But, as the ſeminal fluid is extracted from every part of the body, it is impoſſible to conceive how the body of a female ſhould produce particles proper for the formation of male organs.

This liquor muſt enter, by ſome way or other, into the uterus of viviparous animals; and, in oviparous animals, it muſt be abſorbed by the eggs, which may be regarded as portable matrixes. Each of theſe matrixes, or eggs, contains a ſmall drop of the female fluid, in that part which is called the cicatrice. This prolific drop, when the female has had no communication with the male, aſſumes, as Malpighius obſerves, the form of a mole or inorganic maſs; but, when it is penetrated by the ſemen of the male, it produces a foetus, which is nouriſhed and brought to perfection by the juices of the egg.

Eggs, therefore, inſtead of being common to all females, are only inſtruments employed by Nature for ſupplying the place of uteri in thoſe animals which are deprived of this organ. Inſtead of being active and eſſential to the firſt impregnation, eggs are only paſſive or accidental parts, deſtined for the nouriſhment of the foetus already formed in a particular part of this matrix, by the mixture of the male and female ſemen. Inſtead of exiſting from the creation, and each including within itſelf an infinity of males and females, eggs, on the contrary, are bodies compoſed of a ſuperfluous part of the food, which is more groſs, and leſs organic, than that of which the ſeminal fluid conſiſts. The egg, in oviparous females, anſwers the ſame purpoſes as the uterus and menſtrual flux in the viviparous.

To evince that eggs are deſtined by Nature only to ſupply the place of an uterus in ſuch animals

animals as are deprived of this organ, we muſt conſider, that females produce eggs independent of the male. The uterus, in viviparous animals, is a part peculiar to the female ſex; in the ſame manner, female fowls, that want this organ, have the defect amply ſupplied by the ſucceſſive production of eggs, which neceſſarily exiſt in theſe females, independent of all communication with the male. To pretend that the foetus pre-exiſted in the egg, and that eggs are contained, *ad infinitum*, within each other, is equally ridiculous as to maintain that the foetus pre-exiſted in the uterus, and that the uterus of the firſt female contained all the uteri that ever were or will be produced.

Anatomiſts have applied the term *egg* to things of very oppoſite natures. Harvey, in his aphoriſm, *Omnia ex ovo*, by the word *egg*, when applied to oviparous animals, means only the bag which includes the foetus and all its appendages. He imagined that he perceived the formation of this egg or bag immediately after the junction of the male and female. But this egg proceeded not from the ovarium of the female: He even aſſerts, that he could not diſtinguiſh the ſmalleſt alteration in the ovarium. It is apparent, that there is not here the moſt diſtant analogy to what is commonly underſtood by the word *egg*, unleſs, perhaps, the figure of the bag might have ſome faint reſemblance to that of an egg. Harvey, though he diſſected many viviparous females, never could perceive any change in their ovaria: He even regards them as glands totally unconnected with the purposes of generation *, though, as we have seen, they undergo very considerable changes. This able anatomist was deceived by the smallness of the glandulous bodies in animals of the deer kind, to which his researches were principally confined. Conradus Peyerus, who made many observations on the testicles of female deer, remarks, 'Exigui quidem sunt damarum 'testiculi, sed post coitum foecundum, in alter-'utro eorum, papilla, sive tuberculum fibrosum, 'semper succrescit; scrofis autem praegnanti-'bus tanta accidit testiculorum mutatio, ut me-'diocrem quoque attentionem fugere neque-'ant †.' This author ascribes, with propriety, the reason why Harvey observed no changes in the testicles of the deer, to their smallness. But he is wrong when he tells us, that the changes he had remarked, and which had escaped Harvey, never happened but after impregnation.

Harvey was deceived in several other essential articles. He insists, that the semen never enters the uterus, and that it is impossible it should find admittance; and yet Verheyen found a great quantity of male semen in the uterus of a cow, which he dissected six hours after copulation ‡. The celebrated Ruysch informs us, that, in

* See Harvey, Exercit. 64. and 65.

† See Conrad. Peyer. Merycolog.

‡ See Verheyen, sup. anat. tra. 5. cap. 3.

in diſſecting a woman who had been killed immediately after the act of adultery, he found a conſiderable quantity of male ſemen, not only in the uterus, but in the Fallopian tubes *. Valiſnieri likewiſe aſſures us, that Fallopius, and other anatomiſts had diſcovered male ſemen in the uteri of ſeveral women. This point, therefore, though denied by Harvey, is eſtabliſhed by the poſitive teſtimony of ſeveral able anatomiſts, and particularly by Leeuwenhoek, who found male ſemen in the uteri of many different ſpecies of females.

Harvey mentions an abortion, in the ſecond month, as large as a pigeon's egg, without any appearance of a foetus. In this alſo he muſt have been deceived; for Ruyſch, and ſeveral other anatomiſts, maintain, that the foetus is diſtinguiſhable by the naked eye, even in the firſt month of pregnancy. In the Hiſtory of the French Academy, we have an account of a foetus completely formed on the twenty-firſt day after impregnation. If, to theſe authorities, we add that of Malpighius, who diſtinguiſhed the chick in the cicatrice immediately after the egg iſſued from the body of the hen, we cannot heſitate in pronouncing that the foetus is formed immediately after copulation; and, conſequently, no credit is due to what Harvey ſays concerning the increaſe of the parts by juxta-poſition; ſince theſe parts exiſt from the beginning,

 and

* See Ruyſch Theſ. anat. p. 90. tab. VI. fig. 1.

and gradually expand till the foetus be perfectly mature.

De Graaff differs widely from Harvey in his acceptation of the word *egg*. He maintains, that the female tefticles are real ovaria, and contain eggs fimilar to thofe of oviparous animals, except that they are much fmaller, never fall out of the body, nor detach themfelves till after impregnation, when they defcend from the ovarium into the uterus. The experiments of De Graaff have contributed more to the belief of the exiftence of eggs, than thofe of any other anatomift. They are, notwithftanding, totally void of foundation; for this celebrated author, in the firft place, miftakes the vefìcles of the ovarium for eggs, though they are infeparable from the ovarium, form a part of its fubftance, and are filled with a fpecies of lymph. 2. He is ftill more deceived, when he informs us, that the glandulous bodies are only the coverings of thefe eggs or vefìcles; for it is certain, from the obfervations of Malpighius and of Valifnieri, and from my own experiments, that the glandulous bodies contain no vefìcles. 3. He is wrong in maintaining that the glandulous bodies never appear till after impregnation. On the contrary, thefe bodies are uniformly found in all females, after the age of puberty. 4. He errs in fuppofing that the globules which he faw in the uterus, and which contained the foetufes, were the very vefìcles that had defcended from the ovarium into the uterus, and

and that, he remarks, had become ten times ſmaller than when they were in the ovarium. This circumſtance alone of their diminiſhed ſize ſhould have convinced him of his miſtake. 5. He is equally unfortunate in maintaining that the glandulous bodies are only the coverings of the fecundated eggs, and that the number of coverings or empty follicles always correſpond to the number of foetuſes. This aſſertion is the reverſe of truth; for, on the teſticles of all females, we uniformly find a greater number of glandulous bodies, or cicatrices, than of foetuſes actually produced; and they even appear in thoſe which never brought forth. To this we may add, that neither he, Verheyen, nor any other perſon, ever ſaw the egg in this pretended covering, or in its follicle, though they have thought proper to reſt their ſyſtem upon that ſuppoſition.

Malpighius, who diſtinguiſhed the growth of the glandulous bodies in the female teſticle, was deceived when he imagined that he once or twice diſcovered the egg in their cavities; for this cavity contains only a fluid; beſides, after numberleſs experiments, no man has ever been able to diſcover any thing that had the moſt diſtant reſemblance to an egg.

Valiſnieri, who is never deceived with regard to facts, is wrong in maintaining that the egg muſt exiſt in the glandulous body, though neither

he,

he, nor any man elſe, was ever able to diſcover it.

Let us now attend to what may be eſteemed the real diſcoveries of theſe anatomiſts. De Graaff was the firſt who diſcovered that the teſticles of females ſuffered any change; and he was right in maintaining that they were parts eſſentially neceſſary to generation. Malpighius demonſtrated, that the glandulous bodies gradually grew to maturity, and that, immediately after, they were obliterated, and left behind them a ſlight cicatrice only. Valiſnieri illuſtrated this ſubject ſtill farther. He diſcovered that theſe glandulous bodies were found in the teſticles of all females; that they were conſiderably augmented in the ſeaſon of love; that they increaſed at the expence of the lymphatic veſicles of the teſticle; and that, during the time of their maturity, they were hollow and full of liquor. Theſe are all the truths we have learned concerning the pretended ovaria and eggs of viviparous animals: What concluſions are we to draw from them? Two things appear to be evident: The one, that no eggs exiſt in the teſticles of females; the other, that there is a fluid both in the veſicles of the teſticle, and in the cavity of the glandulous bodies; and we have demonſtrated, in the preceding experiments, that this laſt fluid is the true female ſemen, becauſe it contains, like that of the male, ſpermatic animals, or rather organic particles, in motion.

The

The ſeminal fluid of females, therefore, being thus fully aſcertained, after what has been ſaid, we muſt be ſatisfied that the ſeminal fluid in general is the ſuperfluous organic part of our food, which is tranſmitted from all parts of the body to the teſticles and ſeminal veſſels of males, and to the teſticles and glandulous bodies of females. This liquor, which iſſues through the nipples of the glandulous bodies, perpetually bedews the Fallopian tubes, and may eaſily find admiſſion into them, either by abſorption, or by the ſmall aperture at their extremity, and in this manner may deſcend into the uterus. But, on the ſuppoſition of the exiſtence of eggs, which are ten or twenty times larger than the aperture of the tubes, it is impoſſible to conceive the poſſibility of their being tranſmitted to the uterus.

The liquor ſhed by females in the paroxyſm of love, which De Graaff ſuppoſes to proceed from lacunae about the neck of the uterus and the orifice of the urethra, may be a portion of the ſuperfluous fluid that continually diſtills from the glandulous bodies upon the Fallopian tubes. But perhaps this liquor may be a ſecretion of a different kind, and no way connected with generation. To decide this queſtion, microſcopic obſervations would be neceſſary; but *all* experiments are not permitted even to philoſophers. I am inclined to think, that, in this liquor, the ſame ſpermatic animals, or moving bodies, would be found as appear in the fluid of the glandulous

bodies.

bodies. Upon this ſubject, I might quote the authority of an Italian phyſician, who had an opportunity of trying this experiment, which is thus related by Valiſnieri *: ‘ Aggiugne il lo-‘ dato ſig. Bono d’avergli anco veduti (animali ‘ ſpermatici) in queſta linfa o ſiero, diro coſi ‘ voluttuoſo, che nel tempo dell’ amoroſa zuffa ‘ ſcappa dalle femine libidinoſe, ſenza che ſi po-‘ teſſe ſoſpettare che foſſero di que’ del maſchio,’ &c. If the fact be genuine, as I have no reaſon to doubt, it is certain that this liquor is the ſame with that contained in the glandulous bodies, and, of courſe, that it is a real ſeminal fluid, which eſcapes through the lacunae of De Graaff, ſituated about the neck of the uterus.

Hence we may conclude, that the moſt libidinous females will be the leaſt fruitful, becauſe they throw out of the body that fluid which ought to remain in the uterus for the formation of the foetus. We likewiſe learn why common proſtitutes ſeldom conceive, and why women in warm climates, who have more ardent deſires than thoſe of colder regions, are leſs fertile. But of this we ſhall afterwards have occaſion to treat.

It is natural to imagine that the ſeminal fluid of either ſex ſhould not be fertile, unleſs when it contains moving bodies. But this point is ſtill undetermined. The Italian phyſician, mentioned above, alledges, that he never found ſpermatic animals

* Tom. 2. p. 136.

animals in his ſemen till he arrived at 40 years, although he was the father of many children, and continued, after the animalcules appeared, to beget more.

The ſpermatic moving bodies may be regarded as the firſt aſſemblages of the organic particles which proceed from all parts of the body; and, when a great number of them unite, they become perceptible by means of the microſcope. But, when the number united is ſmall, the body they form is too minute to be viſible, and no motion will appear in the ſeminal fluid, a caſe which not unfrequently happens. But a long train of ſucceſſive experiments would be neceſſary to aſcertain the cauſes of the different ſtates in which this fluid appears.

Of one thing I am certain, from repeated trials, that a ſeminal liquor, though no motion can be perceived when it is firſt taken from the body, after being three or four days infuſed in water, produces as great a number of organic moving particles, as another ſemen, treated in the ſame manner, which at firſt contained vaſt multitudes. Theſe moving bodies appear likewiſe in infuſions of the blood, of the chyle, of the fleſh, and even of the urine, as well as in infuſions of all parts of vegetables; and thoſe which appear in all theſe different ſubſtances ſeem to have nothing peculiar to them. They all move and act nearly in the ſame manner. If we will have theſe bodies to be animated, it muſt be allowed,

lowed, that they are very imperfect, and ought to be regarded only as the rudiments of animals, or rather as bodies composed of particles essential to the existence of animals. As Nature's productions are uniform, and advance by imperceptible degrees, there is no improbability in supposing the existence of organized bodies which properly belong not either to the animal or vegetable kingdoms.

However this matter may stand, it is fully ascertained, that all animal and vegetable substances contain an infinite number of living organic particles. These particles successively assume different forms, and different degrees of activity, according to different circumstances. They are more abundant in the seminal fluids of both sexes, and in the seeds of plants, than in any other part of the animal or vegetable. There exists, therefore, in vegetables and animals, a living substance which is common to them both; and this substance is the matter necessary to their nutrition. The animal is nourished by vegetable or animal substances; and the vegetable is nourished by the same substances in a decomposed state. This common nutritive substance is always alive and active. It produces an animal or vegetable, whenever it finds an internal mould or matrix accommodated to the one or the other, as has already been explained. But, when this active substance is collected too abundantly in a place where it has an opportunity of uniting,

uniting, it forms, in the animal body, other living creatures, as the tape-worm, the aſcarides, the worms ſomtimes found in the veins, in the ſinuſes of the brain, in the liver, &c. Animals of this kind owe not their exiſtence to the generation of individuals of the ſame ſpecies. It is, therefore, natural to think, that they are produced by an extravaſation of the organic matter, or by an inability in the lacteal veſſels to abſorb the quantity of it preſented to them. But we ſhall afterwards have occaſion to examine more in detail the nature of theſe worms, and of other animals which are produced in a ſimilar manner.

When this organic matter, which may be conſidered as an univerſal ſemen, is aſſembled in great quantities, as in the ſeminal fluids, and in the mucilaginous part of the infuſions of plants, its firſt effect is to vegetate, or rather to produce vegetating beings. Theſe zoophytes ſwell, extend, ramify, and then produce globular, oval, and other ſmall bodies of different figures, all of which enjoy a ſpecies of animal life; they have a progreſſive motion, which is ſometimes very rapid, and ſometimes more ſlow. The globules themſelves decompoſe, change their figure, and become ſmaller; and, in proportion as they diminiſh in ſize, the rapidity of their motion increaſes.

I have ſometimes imagined, that the venom of the viper, and even the poiſon of enraged animals,

mals, might proceed from this active matter being too much exalted. But I have not yet had leisure for experiments of this kind, nor for ascertaining the nature of different drugs. All I can say at present is, that infusions of the most active drugs abound with moving bodies, and that they appear sooner in them than in other substances.

Almost all microscopic animals are of the same nature with the moving bodies in the seminal fluids, and in infusions of animal and vegetable substances. The eels in paste, in vinegar, &c. are all of the same nature, and derived from the same origin. But the proofs and illustrations relative to this subject, we shall reserve till we give the particular history of microscopic animals.

CHAP.

CHAP. IX.

Varieties in the Generation of Animals.

THE nutrition and the reproduction of animals and of vegetables, are thus effected by the ſame matter. It is a ſubſtance univerſally prolific, and compoſed of organic particles, the union of which gives riſe to all organized bodies. Nature always works on the ſame ſtock, and this ſtock is inexhauſtible. But the means ſhe employs to give it value are various; and theſe general varieties and affinities merit the attention of philoſophers, becauſe from them we are enabled to account for particular exceptions to the common plan of her operations.

In general, large animals are leſs prolific than ſmall ones. The whale, the elephant, the rhinoceros, the horſe, man, &c. produce but one, and very rarely two, at a birth. But ſmall animals, as rats, herrings, and inſects, produce a great number. Does this difference proceed from the greater quantity of nouriſhment neceſſary to ſupport the large animals than the ſmall, and from the former having a leſs proportional quantity of ſuperfluous nutritive particles,

ticles, capable of being converted into ſemen, than the former? It is certain, that the ſmall animals eat more, in proportion to their bulk, than the large. But it is likewiſe probable, that the prodigious increaſe of the ſmaller animals, as bees, flies, and other inſects, may be owing to the extreme fineneſs and delicacy of their organs and members, by which they are enabled to ſelect the moſt ſubſtantial and moſt organic parts of the animals and vegetables, from which they extract their nouriſhment. A bee, which lives upon the pureſt and moſt refined parts of flowers, receives from its food a greater proportional quantity of organic particles than a horſe, who feeds upon hay, ſtraw, and the groſſer parts of vegetables. The horſe, accordingly, produces but one at a time, while the bee produces many thouſands. The oviparous animals are, in general, ſmaller than the viviparous, and they are likewiſe much more prolific. The long time that the foetus remains in the uterus of viviparous animals, is another obſtacle to multiplication: During geſtation, and the ſuckling of the young, no new generation can take place. But the oviparous animals, which produce, at the ſame time, both uterus and foetus, and throw them out of the body, are almoſt perpetually in a condition to reproduce; and it is well known, that, if a hen be prevented from ſitting, and be fully fed, the number of her eggs may be greatly increaſed. If hens lay not while they brood,

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it is becauſe they ceaſe to eat; and for this purpoſe they leave not their neſts but once a day, and even then for a very ſhort time, leſt their eggs ſhould be injured by the cold. During this operation, they take not above one tenth part of their ordinary nouriſhment.

Animals which produce but one at a birth, acquire nearly their full growth before they are fit for generating. But thoſe which produce many, generate before they are half grown. Man, the horſe, the aſs, the ſheep, are incapable of generation till after they have nearly acquired their full growth. It is the ſame with pigeons and other birds which lay only a ſmall number of eggs: But thoſe which are more prolific, as cocks and hens, fiſhes, &c. begin to generate much ſooner. A cock is capable of this operation at the age of three months, when he is not above one third of his full ſize. A fiſh, which, in 20 years, will weigh 30 pounds, generates the firſt or ſecond year, when it weighs not, perhaps, more than half a pound. But experiments are ſtill wanting to aſcertain the growth and duration of fiſhes: Their age may be diſcovered by examining with a microſcope the annual rings or ſtrata of which their ſcales are compoſed. But we are ignorant how far this may extend. I have ſeen, in the Count de Maurepas' ponds, carps which were well atteſted to be at leaſt 150 years old, and they appeared to be equally active and lively as common carps, I will not ſay with Leeuwenhoek, that fiſhes are immortal, or, at leaſt, that they cannot die of old age. Every thing, in time, muſt periſh. Whatever has an origin, a birth, or commencement, muſt arrive at a termination or death. But fiſhes, by living in a uniform element, and being ſheltered from the injurious viciſſitudes of the air, muſt continue longer in the ſame ſtate than other animals, eſpecially if theſe viciſſitudes, as Bacon remarks, be the chief cauſes of the deſtruction of animated beings. But the principal cauſe of the longevity of fiſhes is, that their bones are ſofter than thoſe of other animals, and do not perceptibly harden with age. The bones of fiſhes lengthen, and turn thick without acquiring more ſolidity. But the denſity of the bones of other animals continually increaſes; and, when their interſtices are completely filled and obſtructed, the circulation of their fluids ceaſes, and death enſues. But, in the bones of fiſhes, this augmentation of ſolidity, which is the natural cauſe of death, proceeds in ſuch an imperceptible manner, that they muſt live very long before they can feel any of the effects of old age.

All quadrupeds covered with hair are viviparous, and thoſe covered with ſcales are oviparous. The cloſe texture of the ſhells or ſcales of oviparous animals prevents them from loſing ſo much matter by tranſpiration, as makes its way through the porous ſkins of the viviparous.

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May not this retention of ſuperfluous nouriſhment, which cannot eſcape by tranſpiration, be one reaſon of the extraordinary fertility of theſe animals, and of their being able to ſubſiſt a long time without food? All birds and flying inſects are oviparous, except ſome ſpecies of flies which produce their young alive *. Theſe have no wings immediately after their birth; but they gradually ſhoot out as the animal advances in growth; and they are not in a condition to be uſed till it acquires full maturity. All ſhell-fiſhes are oviparous; and likewiſe thoſe reptiles that have no feet, as ſnakes and ſerpents; they change their ſkins, which are compoſed of ſmall ſcales. The viper is but a ſlight objection to this general rule; for it is not properly viviparous. It firſt produces eggs, from which the young are hatched: This operation is indeed carried on and completed in the body of the mother; and, inſtead of laying the eggs, like other oviparous animals, the viper hatches them within the body. The ſalamander, in which, as Maupertuis remarks †, both eggs and young are found at the ſame time, is a ſimilar exception in oviparous quadrupeds.

Moſt animals are multiplied and perpetuated by copulation. But many animals, as the greateſt number of birds, propagate rather by a kind of compreſſion, than a proper copulation. Some

 birds;

* See Leeuwenhoek, tom. 4. p. 91.

† Mem. de l'Acad. année 1727, p. 32.

birds, indeed, as the oſtrich, the male-duck, &c. have conſiderable members, and propagate by a real intromiſſion. Male fiſhes approach the females in the ſeaſon of ſpawning. They ſeem to rub their bellies againſt each other; for the male often turns on his back to meet the belly of the female. But no actual copulation takes place. The part neceſſary for this operation does not exiſt; and the males only approach the females for the purpoſe of ſhedding the liquor of their milts upon the eggs, which at that ſeaſon drop from the females. The male ſeems to be more attached to the eggs than to the female; for, when ſhe ceaſes to throw out the eggs, the male inſtantly abandons her, and follows, with ardor, the eggs which are carried down by the ſtream, or diſperſed by the wind. He paſſes and repaſſes a thouſand times over every place where he finds eggs. It is not, ſurely, for the love of the mother that he makes all theſe movements: He cannot even be ſuppoſed to know her; for he has been often ſeen ſhedding his ſemen promiſcuouſly on all the eggs that came in his way, without having ever met with the female to which they belonged.

Thus ſome animals are diſtinguiſhed by ſexes, and endowed with members proper for copulation. There are others which likewiſe have ſexes, but want the neceſſary members. Others, as ſnails, have both members and both ſexes in each individual. Others, as the vine-fretters, have

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no ſexes, are equally fathers and mothers, and produce of themſelves without copulation. Though they ſeem to copulate at pleaſure, we are unable to diſcover the uſe of the junction, or whether it be really a ſexual embrace; unleſs we ſhould ſuppoſe Nature to have endowed this ſmall inſect with generative faculties ſuperior to thoſe of any other ſpecies of animals, and to have beſtowed on every individual not only the power of reproduction, but likewiſe the power of multiplying by ſexual communications.

But, whatever varieties take place in the generation of different ſpecies of animals, Nature prepares the body for it by a new production, which, whether it be external or internal, always precedes generation: Immediately before the ſeaſon of impregnation, the ovaria of oviparous animals, and the teſticles of the females of the viviparous, undergo a conſiderable change. The oviparous animals produce eggs, which gradually increaſe in ſize, till they quit the ovarium and fall into the canal of the uterus, where they receive their white, their membranes, and their ſhell. This production marks the fecundity of the female, and without which generation could not be effected. In viviparous females, in the ſame manner, one or more glandulous bodies appear upon the teſticles, which gradually grow under the membranes that cover them. Theſe glandulous bodies increaſe, and pierce, or rather elevate the membrane of the teſticle; and, when they arrive at maturity, a fiſſure, or ſeveral little holes, appear at their extremities, through which the ſeminal fluid eſcapes, and falls into the uterus. Theſe glandulous bodies are new productions, which always precede generation, and without which it could not be effected.

Males undergo a ſimilar change before they are fit for the purpoſes of generating. In the oviparous animals, the ſeminal reſervoirs are filled, and ſometimes the reſervoirs themſelves are annually renewed. The milts of ſome fiſhes, and particularly of the calmar, are renewed every year. The teſticles of birds, immediately before the ſeaſon of their amours, ſwell to an enormous degree. The teſticles of the males of viviparous animals, eſpecially of thoſe which have ſeaſons, likewiſe ſwell conſiderably; and, in general, the genitals of every ſpecies ſuffer an erection, which, though it be external and caſual, may be regarded as a new production that neceſſarily precedes the faculty of generating.

Thus in all animals, whether male or female, generation is always preceded by new productions; and, when there is properly no new productions, ſome of the parts ſwell and extend to a remarkable degree. In ſome animals, not only a new production appears, but their whole bodies are renewed, before generation can be effected; as happens in the ſurpriſing metamorphoſis of inſects, which ſeems to be intended for no other purpoſe than to enable theſe animals

mals to propagate their ſpecies; for their bodies are full grown before they are transformed. The inſect, immediately before its transformation, ceaſes to take nouriſhment; and it has no organs proper for generation, no means of converting the nutritive particles, with which it abounds more than any other ſpecies of animals, into eggs, or a ſeminal fluid. Hence the whole of this great ſurplus of nutritive particles at firſt unites and moulds itſelf into a form nearly reſembling that of the original animal. The caterpillar becomes a butterfly, becauſe, having no organs of generation, no reſervoirs for containing the ſuperfluous nutritive particles, and, conſequently, being incapable of producing minute organic bodies ſimilar to the animal itſelf, the organic nutritive particles, which are always active, aſſume, by their union, the form of a butterfly, partly reſembling that of a caterpillar, both internally and externally, except that the parts of generation are unfolded, and rendered capable of receiving and tranſmitting the nutritive organic particles which form the eggs and individuals peculiar to the ſpecies. The individuals produced by the butterfly ought not to be butterflies, but caterpillars; becauſe it was the caterpillar that received the nouriſhment, and becauſe the organic particles of this nouriſhment muſt therefore be aſſimilated into the form of a caterpillar, and not of a butterfly, which is only an occaſional production of the ſuperfluous nouriſhment

nouriſhment that precedes the real production of animals of this ſpecies, and a method employed by Nature to accompliſh the important purpoſes of generation, ſimilar to the production of glandulous bodies, and of milts, in other animals.

When the ſuperabundant quantity of organic nutritive particles is not great, as in man, and moſt large animals, generation does not take place till the growth of the body is nearly completed; and even their prolific powers are limited to a ſmall number of young: But, when theſe particles are more abundant, as in birds, and oviparous fiſhes, generation is effected before the animal be fully grown, and the production of individuals is very numerous. When the quantity of organic nutritive particles is ſtill greater, as in inſects, it firſt produces a large organized body, retaining the internal and eſſential conſtitution of the animal, but differing in ſeveral parts as the butterfly differs from the caterpillar; and then it quickly generates an amazing number of young, ſimilar to the animal that firſt prepared the organic nouriſhment from which they derived their origin. Laſtly, when the quantity of ſuperfluous nouriſhment is very great, and when the animal, at the ſame time, poſſeſſes the organs neceſſary to generation, as in the vine fretters, it firſt confers on each individual the power of generating, and then a transformation like that which other inſects undergo: The vine fretter becomes a flie; but

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it can produce nothing, becauſe it is only the reſidue of the organic particles that had not been employed in the production of the young.

Almoſt all animals, man excepted, have certain annual ſeaſons appropriated to the purpoſes of generation. To birds, ſpring is the ſeaſon of love: Carps, and ſeveral other fiſhes, ſpawn in June and Auguſt. Pikes, and ſome other fiſhes, ſpawn in the ſpring. Cats have three ſeaſons annually, in the months of January, May, and September. The roe-deer rut in December, wolfs and foxes in January, horſes in ſummer, ſtags in September and October; and almoſt all inſects generate during the autumn only. Some animals, as the inſects, are totally exhauſted by generation, and die ſoon after. Others, though they die not, become feeble, are much emaciated, and require a conſiderable time to repair the great waſte of their organic ſubſtance. Others are leſs affected, and are capable of frequently renewing their amours; laſtly, man is very little affected, or, rather, he quickly repairs the loſs, and therefore is, at all times, in a condition for propagating. All theſe varieties depend ſolely on the particular conſtruction of the animal organs. The limits fixed by Nature upon the modes of exiſting are equally conſpicuous in the manner of taking and digeſting the food, in the means employed for retaining or throwing it out of the body, and in the inſtruments by which the organic particles neceſſary

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to reproduction are extracted. And, upon the whole, it is apparent, that every thing exists which can exist.

The times of the gestation of females are equally various: Some, as mares, carry their young from eleven to twelve months; others, as women, cows, and hinds, carry their young nine months; others, as foxes and wolves, carry five months; bitches carry nine weeks, cats six weeks, and rabbits thirty-one days. Most birds are hatched in twenty-one days; though some of them, as the thistle-finches, hatch in thirteen or fourteen days. Here the variety is equally great as in every other part of the oeconomy of animals: The largest animals produce fewer young, and carry them longest, which confirms the doctrine, that the quantity of organic nourishment is proportionally less in large than in small animals; for the foetus derives its growth and the expansion of its parts from the superfluous nourishment of the mother; and, as this growth requires longer time in large than in small animals, it is a proof that the quantity of organic particles is not so great in the former as in the latter.

Animals, therefore, are much diversified as to the time and manner of gestation, of engendering, and of producing; and this variety originates from the very causes of generation. For, though the organic matter, which is common to every thing that lives or vegetates, be the gene-

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ral principle of reproduction, the manner of its union, and the combinations it forms, muſt be infinitely varied, that the whole may become the ſources of new productions. My experiments clearly demonſtrate, that there are no pre-exiſting germs, and that the generation of animals and vegetables is not univocal. There are, perhaps, as many beings, which either live or vegetate, produced by a fortuitous aſſemblage of organic particles, as by a conſtant and ſucceſſive generation. It is to ſuch productions that we ought to apply the axiom of the ancients, *Corruptio unius, generatio alterius.* The corruption and reſolution of animals and vegetables produce an infinite variety of organized bodies: Some of them, as thoſe of the calmar, are only a kind of machines, which, though exceedingly ſimple, are very active. Others, as the ſpermatic animalcules, ſeem to imitate the movements of animals. Others reſemble vegetables in their manner of growth and expanſion. There are others, as thoſe of blighted wheat, which, at pleaſure, can be made alternately to live or to die; and it is difficult to know to what they ſhould be compared. There are ſtill others, and in great numbers, which are at firſt a kind of vegetables, then become a ſpecies of animals, and again return alternately to their vegetable ſtate. The more we examine this ſpecies of organized bodies, we ſhall probably diſcover greater and more ſingular varieties of them, in proportion as they are

are farther removed from our obſervation, and from the ſtructure of other animals with which we are already acquainted.

For example, blighted corn, which is effected by an alteration or reſolution of the organic ſubſtance of the grain, is compoſed of multitudes of ſmall organized bodies reſembling eels. When infuſed in water for ten or twelve hours, we diſcover them to have a diſtinct wreathing, and a ſmall degree of progreſſive motion. They ceaſe to move as ſoon as the water fails them; and their motion commences upon the addition of freſh water. This alternate death and reviviſcence may be repeated for months, and even for years; ſo that theſe ſmall machines may be made to act as long and as often as we pleaſe, without deſtroying or diminiſhing their force. They are a ſpecies of machines, which begin to act whenever they are immerſed in a fluid. Theſe filaments ſometimes open like the filaments of the ſemen, and produce moving globules: We may, therefore, conclude them to be of the ſame nature, except that they are more fixed and ſolid.

The eels in paſte have no other origin than the union of the organic particles of the moſt eſſential parts of the grain. The firſt eels which appear are certainly not produced by other eels; but, though they are not propagated themſelves, they fail not to engender other living eels. By cutting them with the point of a lancet, we diſ-

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cover ſmaller eels iſſuing in great numbers out of their bodies. The body of this animal ſeems to be only a ſheath or ſac containing a multitude of ſmaller animals, which perhaps are other ſheaths of the ſame kind, in which the organic matter is aſſimilated into the form of eels.

A great number of experiments would ſtill be neceſſary to diſtinguiſh theſe animals, which are ſo ſingular and ſo little underſtood, into claſſes and genera. Some of them may be regarded as real zoophytes, which enjoy a kind of vegetation, and which, at the ſame time, ſeem to wreath and move like animals. Others appear, at firſt, to be animals, and then join and form a ſpecies of vegetables. A ſmall attention to the reſolution of a ſingle grain of corn will elucidate, at leaſt in part, what I have ſaid on this ſubject. I might add other examples; but thoſe I have given were only produced for the purpoſe of exhibiting the varieties of generation. There are unqueſtionably ſeveral organized bodies which we conſider as real animals, but which are not engendered by others of the ſame ſpecies. Some of them are only a kind of machines; and ſome of theſe machines have a certain limited effect, and act for a certain time only, as the machines in the milt of the calmar; others may be made to act as long and as often as we pleaſe, as thoſe of blighted grain. There are vegetables which produce animated bodies, as the filaments of the human ſemen, from which active globules iſſue and

and move by their own powers. In the corruption, the fermentation, or rather in the reſolution of animal or vegetable ſubſtances, we find real animals capable of propagating their ſpecies, though they were not themſelves produced in this manner. Theſe varieties are, perhaps, more extenſive than we imagine. Though it be right to generalize our ideas, to aſſemble the effects of Nature under one point of view, and to claſs her productions; yet numberleſs ſhades, and even degrees, in the great ſcale of being, will always eſcape our obſervation.

CHAP.

C H A P. X.

Of the Formation of the Foetus.

FROM the experiments of Verheyen, who found the ſemen of the bull in the uterus of a cow, and from thoſe of Ruyſch, Fallopius, and Leeuwenhoek, who diſcovered male ſemen in the uteri of women and many other animals, it ſeems to be a point fully aſcertained, that the ſemen of the male enters into the uterus of the female. It is probable, that, during the time of coition, the orifice of the uterus opens for the reception of the ſeminal fluid: But, though this ſhould not happen, the active and prolific part of the ſemen may penetrate the membranes and ſubſtance of the uterus itſelf; for, as the ſeminal liquor, as formerly remarked, is almoſt entirely compoſed of organic particles, which are very active, and extremely minute, they may paſs with the utmoſt facility through the membranes and ſubſtance of the uterus.

What proves that the active part of this fluid may paſs through the pores and ſubſtance of the uterus, is the ſudden change it undergoes immediately after conception. The menſes are obſtructed,

obſtructed, the uterus becomes flaccid, ſwells, and appears to be inflated. All theſe changes muſt be effected by an active external cauſe, by the penetration of part of the ſeminal fluid into the ſubſtance of the uterus. This penetration is not confined to the ſurface; it extends through all the veſſels and parts of which the uterus is compoſed, like that penetration by which nutrition, and the expanſion of the body, is produced.

We ſhall the more eaſily believe this to be the caſe, when we reflect, that, during the time of geſtation, the uterus not only augments in ſize, but even in its quantity of matter, and that it poſſeſſes a ſpecies of life, or rather of vegetation, which continues till the child be delivered. If the uterus were only a ſac, a reſervoir for receiving the ſemen and retaining the foetus, it would extend and diminiſh in thickneſs, in proportion as the foetus grew larger. But the augmentation of the uterus is not a ſimple extenſion or dilatation of its parts. It not only extends as the foetus enlarges, but it acquires, at the ſame time, an additional thickneſs and ſolidity; or, in other words, both its ſize and quantity of matter are greatly increaſed. This augmentation is a real growth or increaſe of ſubſtance, ſimilar to the expanſion of the body in young animals, which could not be effected but by an intimate penetration of organic particles analogous to the ſubſtance of thoſe parts. As this expanſion

expanſion of the uterus never happens but after impregnation, the ſeminal liquor muſt be the cauſe by which it is produced; for the uterus is conſiderably augmented before the foetus has acquired bulk enough to dilate it by preſſing againſt its internal ſurface.

It appears, from my own experiments, to be equally certain, that the female has a ſeminal fluid, which begins to be formed in the teſticles, and is brought to maturity in the glandulous bodies. This fluid perpetually diſtills through the ſmall apertures in the extremities of theſe bodies, and, like that of the male, enters the uterus by two different ways, either through the apertures at the extremities of the horns of the uterus, or by piercing through the ſubſtance of the uterus itſelf.

Theſe two ſeminal fluids are extracts from all parts of the body; and a mixture of them is all that is neceſſary for the formation of a certain number of males and females. The more any animal abounds in this ſeminal fluid, or the more it abounds in organic particles, the number of young is the greater, as may be remarked in the ſmaller animals; and the number of young diminiſhes in proportion as the organic particles are leſs abundant, as is the caſe with the larger animals.

But, before taking any farther notice of other animals, we ſhall examine with attention the formation of the human foetus. In mankind, as well as in the larger ſpecies of animals, the quantity of organic particles in the male and female ſemen is not great, and, accordingly, they very ſeldom produce above one foetus at a time. This foetus is either a male or a female, according as the number of organic particles predominates in the male or in the female fluid; and the child reſembles the father or the mother moſt, according to the proportional quantities of male or female organic particles in the mixture of the two liquors.

I conceive, therefore, that the ſeminal fluids, both of the male and of the female, are equally active, and equally neceſſary for the purpoſes of propagation: And this, I think, is fully proved by my experiments; for I found in both fluids the ſame moving bodies; I diſcovered that the male fluid enters the uterus, where it meets with the fluid of the female; that theſe two fluids are perfectly analogous; and that they are compoſed of parts not only ſimilar in their form, but in their action and movements *. Now, I imagine, that, by the mixture of the two fluids, the activity of the organic particles proper to each is ſtopped; that the action of the one counterbalances the action of the other; that each organic particle, by ceaſing to move, remains fixed in the place which correſponds to its nature; and that this place can be no other than that which it formerly occupied in the body of the animal from which it was extracted. Thus all the organic particles which were detached from the head of

* See. Chap. VI.

of the animal, will arrange themſelves in a ſimilar order in the head of the foetus. Thoſe which proceeded from the back bone, will diſpoſe themſelves in an order correſponding to the ſtructure and poſition of the vertebrae. In the ſame manner, the organic particles which had been detached from any part of the body, will naturally aſſume the ſame poſition, and arrange themſelves in the ſame order that they obſerved before they were ſeparated from that part. Of courſe, theſe particles will neceſſarily form a ſmall organized body, entirely ſimilar to the animal from which they originally proceeded.

It is worthy of remark, that this mixture of the organic particles of both ſexes contains particles which are ſimilar, and particles which are diſſimilar. The ſimilar particles are thoſe which have been detached from all the parts that are common to the two ſexes. The diſſimilar particles are thoſe which have been ſeparated from the parts that diſtinguiſh the two ſexes. In this mixture, therefore, there is a double portion of particles deſtined for the formation of the head, the heart, and ſuch parts as are common to both ſexes; while there are no more than what are neceſſary for the production of the ſexual parts. Now, the ſimilar particles may act upon each other without producing any diſorder; and they may unite in the ſame manner as if they had proceeded from the ſame body. But the diſſimilar parts cannot act upon each other, nor form any intimate union, becauſe they have no analogy or relation: Hence theſe particles will preſerve their original nature without any mixture, and fix their poſition, without the neceſſity of being penetrated by others. Thus the particles which proceed from the ſexual parts will be firſt fixed, and thoſe that are common to the two ſexes, whether they belong to the male or to the female, will then fix indiſcriminately, and form an organized body, which, in its ſexual parts, will perfectly reſemble the father, if it be a male, and the mother, if it be a female, but which, in the other parts, may reſemble either or both.

If what I have advanced be properly underſtood, we ſhall, perhaps, be able to obviate an objection to the ſyſtem of Ariſtotle, and which might alſo be urged againſt the doctrine which I am now eſtabliſhing. The objection is, Why is not every individual, both male and female, endowed with the faculty of producing an animal of its own ſex? I am aware of the difficulty of ſolving this queſtion, which I have ſlightly mentioned in the fifth chapter, and ſhall now proceed farther to illuſtrate.

From what is delivered in the firſt four chapters, and from the experiments I have related, it is apparent, that reproduction is effected by the aſſemblage and union of the organic particles, detached from every part of the animal or vegetable body, in one or ſeveral common reſervoirs; that theſe particles are the ſame which ſerve for the nutrition and expanſion of the body;

body; and that both effects are produced by the same matter, and by the same laws. I think I have established this point by so many facts and reasonings, that it is impossible to entertain a doubt concerning its truth. But I allow, that the question may be put, Why every separate animal and vegetable produces not its own likeness; since every individual detaches from all its parts, and collects, in a common reservoir, the organic particles necessary for the formation of a small organized body? Why is not this organized body formed? and why, in most animals, is a mixture of the fluids of both sexes necessary? If I were to reply, that, in all the vegetable tribes, in all those animals that multiply by cuttings, and in the vine-fretters, which produce without any sexual commerce, the general intention of Nature seems to be, that each individual should multiply its own species, and that reproduction by the intervention of sexes is only an exception to this general law. It might, with propriety, be rejoined, that the exception is perhaps more universal than the rule itself. To maintain that all individuals would have the faculty of reproducing, if they were endowed with proper organs, and if they contained the matter necessary for nourishing the embryo, is not removing the difficulty: For, in females, all these circumstances concur; and yet the influence of the male is indispensible to the production either of a female or of a male foetus.

But, we come nearer a ſolution of the queſtion, when we maintain, that, though the fluid in the teſticles and ſeminal veſſels of the male contain all the organic particles neceſſary for the formation of a male foetus, yet theſe particles cannot receive any local eſtabliſhment or arrangement of parts, becauſe a conſtant circulation of them goes on by means of abſorption, and by the perpetual ſucceſſion of new ſupplies from all parts of the body; and that, as the ſame circulation of the organic particles takes place in the female, neither of them can poſſibly multiply without the aſſiſtance of the other; becauſe, in the mixture of the male and female fluids, the different organic particles of which they conſiſt have a greater affinity to each other than they have to the body of the female where the mixture happens. But, though this explication were admitted, why, it may ſtill be aſked, does not the ordinary mode of generation correſpond with it? For, upon this ſuppoſition, each individual would produce, and, like ſnails, mutually impregnate one another, every individual receiving the organic particles furniſhed by the other, which, without being injured by any foreign power, would unite ſolely by the affinity between the particles themſelves. If there were no other cauſe by which the organic particles could be united, perhaps this mode of generation would be the moſt ſimple. But it is contrary to the analogy of Nature.

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Few animls are endowed, like ſnails, with both ſexes; and, therefore, if this mode of propagating were the moſt ſimple, it would be more generally employed by Nature. This ſolution, of courſe, amounts to no more than a gratuitous ſuppoſition, that males produce not, ſolely becauſe they have not organs proper for containing and nouriſhing a foetus.

It may be ſtill farther ſuppoſed, that the activity of the organic particles in the ſemen of each individual requires to be counterbalanced by the force or action of thoſe of the other individual, in order to reduce them to a fixed ſtate, or equilibrium, without which the formation of the foetus cannot be effected; and that the motion of the organic particles of the female cannot be counterbalanced by any other cauſe than a contrary action in the organic particles received from the male. But this anſwer is too general to be void of obſcurity. However, when we attend to all the phaenomena, it may, perhaps, admit of ſome illuſtration. The mixture of the two ſeminal fluids produces not only a male or female foetus, but other organized bodies, which are endowed with the faculty of growth or expanſion. The placenta, the membranes, &c. are produced at the ſame time, if not ſooner, than the foetus. There are, therefore, in the ſeminal fluid of the male or female, or in the mixture of both, organic particles not only ſuited to the production of the foetus, but of the placenta

placenta and membranes. Since there are no parts either in the male or female bodies from which they could be detached, whence do these particles proceed? It must be admitted, that the organic seminal particles of each sex being equally active, uniformly produce organized bodies every time that they can fix themselves, by their mutual action upon one another; that, of the particles destined to produce a male, those peculiar to the male sex will fix first, and form the sexual parts; that the particles common to both sexes may afterwards fix themselves indifferently, in order to form the rest of the body; and that the placenta and membranes are produced by the excess of organic particles which have not been employed in the formation of the foetus. If, as we have supposed, the foetus be a male, all the organic particles peculiar to the female sex, which have not been employed, as also the superfluous particles of both individuals which have not entered into the composition of the foetus, and which cannot be less than one half of the whole, remain for the formation of the membranes and placenta. If the foetus be a female, the same quantity of superfluous organic particles still remain, and are occupied in forming the placenta and membranes.

But it may be said, that the membranes and placenta, upon this supposition, ought to become another foetus, which would be a male, if the first was a female, and a female, if the first was a male; because the first foetus consumed only the organic particles peculiar to the sex of one individual, and the half of those particles which were common to both sexes; and, of course, the sexual particles of the other individual, and the other half of the common particles, remain still unexhausted. To this I reply, that the first union of the organic particles prevents a second, at least under the same form; and that the foetus, being first formed, exerts an external force, which destroys the natural arrangement of the other organic particles, and throws them into that order which is necessary for the formation of the placenta and membranes.

From the experiments and observations formerly made, it is apparent, that all animated beings contain an amazing quantity of living organic particles. The life of an animal or vegetable seems to be nothing else than a result of all the particular *lives* (if the expression be admissible) of each of these active particles, whose life is primitive, and perhaps indistructible. These living particles we have found in every animal and vegetable substance; and we are certain, that all these particles are equally necessary to the nutrition, and, consequently, to the reproduction of animals and vegetables. That the union of a certain number of these particles, therefore, should produce an animated being, it is not difficult to conceive. As each particle is animated, a whole, or any assemblage of them, must

muſt be endowed with life. Theſe living organic particles being common to all animated beings, they are capable of forming particular ſpecies of animals or of vegetables, according to the peculiar arrangement they aſſume. Now, this arrangement depends entirely on the form of the individuals which furniſh the organic particles. If they are furniſhed by an animal, they arrange themſelves under the form peculiar to its ſpecies, exactly agreeable to that arrangement they obſerved when they nouriſhed or expanded the animal itſelf. But, does not this regular arrangement ſuppoſe the neceſſity of ſome baſe or centre, round which the particles aſſemble in order to unite and form a foetus? This baſis is furniſhed by the particles which form the ſexual parts. I ſhall illuſtrate this point.

As long as the organic particles of either ſex remain alone, their activity produces no effect, becauſe it is not oppoſed by any reſiſtance or reaction from particles of a different kind. But, when the male and female liquors are blended, the particles detached from the ſexual parts, being of a different kind, ſerve as a baſe to fix the activity of the other particles.

Upon this ſuppoſition, that the organic particles which, in the mixture of the two fluids, repreſent the ſexual parts of the male, can alone ſerve as a baſis to the particles which proceed from all parts of the female; and that thoſe proceeding from all parts of the male can only

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be fixed by the particles which are detached from the ſexual parts of the female; we may conclude, that the ſexual parts of the male foetus are formed by the organic particles of the father, and the reſt of its body by the organic particles of the female; and, on the contrary, that the female foetus derives nothing but its ſex from the mother, and the reſt of its body from the father. Boys, therefore, except in the parts which diſtinguiſh their ſex, ought to reſemble the mother more than the father, and girls ſhould reſemble the father more than the mother.

Conſidering generation by ſexes under this light, we ſhould conclude it to be the moſt common manner of reproduction, as it is in reality. Beings of the moſt perfect organization, as animals, whoſe bodies make a whole that is incapable of diviſion, and whoſe powers are all concentrated into one point, cannot be reproduced in any other way; becauſe they contain only particles that are perfectly ſimilar, and cannot be united but by means of different particles furniſhed by another individual. But vegetables, which are leſs perfect in their organization, and which can be divided without deſtruction, are capable of being reproduced in different ways: 1. Becauſe they contain diſſimilar particles; 2. Becauſe the form of theſe bodies is leſs fixed and determined than that of an animal, different parts may ſupply the functions of each other,

ther, and vary according to circumſtances: The roots of a tree, when expoſed to the air, puſh out branches and leaves; and thus the organic particles of vegetables obtain a local eſtabliſhment, become fixed, and produce individuals in many different ways.

The ſame phaenomenon is exhibited in animals whoſe organization is leſs perfect, as in the freſh water polypus, and others, which are capable of reproducing by the diviſion of their parts. Theſe organized bodies, inſtead of ſingle animals, may be conſidered as bundles of organized beings united by a common membrane, as trees are compoſed of an infinite number of minute trees *. The vine-fretters, which propagate individually, likewiſe contain diſſimilar particles; becauſe, after producing their young, they change into barren flies. Snails mutually communicate diſſimilar particles to each other; and, therefore, each individual is fruitful. Thus, in every mode of generation with which we are acquainted, we find, that the neceſſary union of the organic particles cannot be effected but by the admixture of different particles, to ſerve as a common baſis, and to fix or deſtroy their activity.

According to this general idea of ſexes, we may ſuppoſe, that the diſtinction of ſex extends through all Nature; for *ſex*, in this ſenſe, is nothing but that part of bodies which furniſhes organic

* See Chap. II.

organic particles of a different kind from thoſe of the common parts, and which ſerve as a baſis for their union. But it is, perhaps, uſeleſs to reaſon on a queſtion which can be ſolved at once, by ſaying, that, as God has created ſexes, animals muſt neceſſarily be produced by their intervention. We are not in a condition, as I formerly remarked, to explain *why* things exiſt; we are unable to explain *why* Nature almoſt univerſally employs ſexes for the reproduction of animals, or *why* ſexes exiſt. We ought, therefore, to content ourſelves with reaſoning concerning things as they are. If we attempt to riſe higher, we loſe ourſelves in the regions of fancy, and forget the narrow limits of our capacity.

Leaving, therefore, all further ſubtleties, I ſhall adhere to nothing that is not founded on facts and obſervation. I find that the reproduction of bodies is effected in many different modes: But, at the ſame time, I clearly perceive, that animals and vegetables are reproduced by the union of the organic particles detached from all parts of their bodies. I am certain that theſe active organic particles exiſt in the ſeeds of vegetables, and in the ſeminal fluids of animals, both male and female; and have no doubt that every ſpecies of reproduction is accompliſhed by the union and admixture of theſe particles. It is equally unqueſtionable, that, in the generation of man, and other animals, the organic particles

particles of the male and female mix at the time of conception; becauſe we often ſee children who reſemble both father and mother: And, what confirms this theory is, that all the particles common to the two ſexes mix together promiſcuouſly, but that the particles peculiar to the ſexes never mix; for we daily perceive children with eyes reſembling thoſe of the father, while their mouth and front reſemble thoſe of the mother. But we never ſee any ſuch mixture of reſemblances in the ſexual parts; we never find, in the ſame individual, the teſticles of the father and the vagina of the mother.

The formation of the foetus, therefore, is effected by the mixture of the organic particles of both ſexes; and this mixture fixes or gives a local eſtabliſhment to the particles, becauſe it is made according to the laws of affinity which take place between the different parts, and which determine the particles to arrange themſelves in the ſame order they obſerved when they exiſted in the individuals who furniſhed them. The particles which proceed from the head, for example, cannot, according to theſe laws, take up their ſtation in the legs, or in any other part but the head of the foetus. All the particles are in motion when they firſt unite; and this motion muſt be round the point or centre of union. This baſis or central point, which is neceſſary to the union of the particles, and which, by its reaction and inertia, fixes and deſtroys their activity,

tivity, is probably the firſt aſſemblage of particles that proceed from the ſexual parts, becauſe they are the only particles in the mixture which differ from thoſe common to both ſexes.

I imagine, therefore, that, in the mixture of the two fluids, the organic particles which come from the ſexual parts of the male fix themſelves firſt, and cannot unite with thoſe which proceed from the ſexual parts of the female, becauſe they are of a different nature, and have leſs affinity to each other than the particles that come from the eye, the arm, or any other part of the female. Round this centre, or point of union, the other organic particles ſucceſſively arrange themſelves in the ſame order they formerly exiſted in the body from which they were derived; and, according as the particles of the one or of the other individual moſt abound, or are nearer this central point, they enter in greater or leſs quantities into the compoſition of the new being, which, in this manner, is formed in the middle of a homogeneous fluid; at the ſame time, veſſels begin to ſhoot, which increaſe in proportion to the growth of the foetus, and furniſh it with proper nouriſhment. Theſe veſſels, which have a peculiar ſpecies of organization, are probably formed by the exceſs of the organic particles that have not been admitted into the compoſition of the foetus; for, as theſe particles are both active, and furniſhed with a baſe or point of union from the organic particles peculiar

liar to the ſexual parts of the other individual, they muſt arrange themſelves in the form of an organized body, but not in the form of another foetus; becauſe their poſition with reſpect to each other has been changed by the different movements of the particles which entered into the compoſition of the firſt foetus. From the union of theſe ſuperabundant particles, therefore, an irregular body muſt ariſe, which will reſemble the foetus in nothing but its growth and expanſion, becauſe, though this body be compoſed of the ſame organic active particles with the foetus, their poſition and form muſt be different, as they were thrown aſide from the centre or point of union, which ſerved as a baſis for the formation of the foetus.

When the quantity of ſeminal fluid of both individuals is great, or, rather, when theſe liquors abound with organic particles, different centres of attraction are formed in different parts of the mixture; and, in that caſe, by a mechaniſm ſimilar to what has been mentioned above, ſeveral foetuſes are formed, ſome of them males, and others females, according as the particles of the one ſex or of the other are moſt active. But, from the ſame centre of attraction, two foetuſes can never originate; becauſe two centres are requiſite for this purpoſe. Beſides, if this arrangement were to happen, no particles would be left for the formation of the placenta and membranes; becauſe they would all be employed in conſtituting the ſecond

ſecond foetus, which would neceſſarily be a female, if the other was a male. All that could happen in a caſe of this kind would be, that ſome of the particles common to both individuals, being equally attracted by the firſt centre of union, muſt arrive there at the ſame time, and produce a monſter, or a foetus with ſuperfluous parts; or, if ſome of the common particles ſhould fix at too great a diſtance from the firſt centre, or be conſtrained by the attraction of the ſecond, round which the placenta is formed, a monſter, defective in ſome part, would be the conſequence.

That the organic particles peculiar to the ſexual parts ſerve for a baſis or centre of union to the other particles of which the embryo is formed, I pretend not to demonſtrate: But, as they are the only particles which differ from the reſt; it is more natural to imagine that they ſhould anſwer this purpoſe than thoſe which are common to both individuals.

I formerly detected the errors of thoſe who maintained, that the heart, or the blood, were firſt formed. The whole is formed at the ſame time. We learn from actual obſervation, that the chicken exiſts in the egg before incubation: The head, the back-bone, and even the appendages which form the placenta, are all diſtinguiſhable. I have opened a great number of eggs, both before and after incubation, and I am convinced, from the evidence of my own eyes, that the whole chicken exiſts, in the middle of the cicatrice, the moment the egg iſſues from the body of the hen. The heat communicated to it by incubation, expands the parts only, by putting the fluids in motion. But we have never been able to determine, with certainty, what parts of the foetus are firſt fixed, at the moment of its formation.

I have always maintained, that the organic particles were fixed, and that they united in conſequence of their motion being ſuſpended. Of the truth of this fact I am fully convinced; for, if the male and female ſemen be ſeparately examined, we find in both a great number of moving particles; but, when theſe fluids are mixed, the motion of the particles is totally deſtroyed, and a certain degree of heat is neceſſary to renew their activity; for the chicken, which exiſts in the centre of the cicatrice, has no motion before incubation; and, even 24 hours, or two days afterwards, when we begin to perceive it without the microſcope, it has not the ſmalleſt appearance of motion. During the firſt two or three days, the foetus is only a ſmall white mucilaginous maſs, which gradually acquires conſiſtence and magnitude. But this progreſs is exceedingly ſlow, and has no reſemblance to the rapid movements of the organic particles in the ſeminal fluid. Beſides, I maintained, not without reaſon, that the motion of the organic particles was entirely deſtroyed; for, if eggs be kept without expoſing them to the degree of heat

heat that is neceſſary for the expanſion of the chicken, the embryo, though completely formed, will remain without any motion, and the organic particles of which it is compoſed will continue fixed, without being able to give life and motion to the embryo which was formed by their union. Thus, after the motion of the organic particles is ſtopped, and after they have united in ſuch a manner as to form a foetus, ſome external cauſe is ſtill neceſſary to give them life and motion. This cauſe, or agent, is heat, which by rarifying the fluids, obliges them to circulate: This circulation makes all the organs act; and nothing farther is neceſſary for the growth and expanſion of the parts than the continuation of this heat.

Before the action of this external heat, there is not the ſmalleſt appearance of blood; and I never could perceive any change of colour in the veſſels till about 24 hours after incubation. In the veſſels of the placenta, which communicate with the body of the foetus, the blood firſt appears. But it would ſeem that this blood loſes its red colour, as it approaches the body of the animal; for the chicken is entirely white; and, during the firſt, ſecond, and third days after incubation, we can with difficulty perceive a few red particles near the animal's body, but which ſeem not to make any part of it, though theſe red particles are deſtined for the formation of the heart. Thus the formation of blood is an effect produced by the motion communicated to the fluids by heat; and even this blood is formed without the body of the animal, the whole substance of which consists of a white mucilage.

The foetus, as well as the placenta, receive the nourishment that is necessary for their expansion by a species of absorption; and they assimilate the organic particles of the liquor in which they swim: For, it is an equal impropriety to say that the placenta nourishes the animal, as that the animal nourishes the placenta. If the placenta nourishes the foetus, the former would diminish in proportion to the growth of the latter, which by no means happens; for both augment together. I have indeed observed, that, in eggs, the placenta at first grows much more in proportion than the foetus, and, consequently, it may nourish the animal; or, rather, it conveys nourishment to the chick by means of absorption.

What we have said concerning the chicken, admits of an easy application to the human foetus, which is formed by the union of the organic particles of the two sexes. The membranes and placenta are produced by the superabundant particles that enter not into the composition of the foetus, which is now inclosed in a double membrane, containing also a quantity of fluid. This fluid is at first perhaps, nothing but a portion of the seminal liquors of the father and mother; and, as the foetus is not thrown out of the uterus, it enjoys, from the moment of its formation,

tion, as much external heat as is ſufficient for its expanſion. This heat communicates motion to the fluids; it gives play to all the organs; and the blood is formed in the placenta, and in the body of the foetus, ſolely by the motion excited by the heat. We might even maintain, that the formation of the blood in a child is as independent of the mother, as that which ariſes in the egg is independent of the hen that covers it, or of the furnace which heats it.

It is certain that the foetus, the membranes, and the placenta, are all nouriſhed and expanded by abſorption; for, at firſt, the ſac that contains the whole product of generation does not adhere to the uterus: And we have ſeen, from the experiments of De Graaff upon female rabbits, that he made the globules which contained the foetuſes roll about in the uterus. They could receive no nouriſhment, therefore, but by abſorbing the fluids that conſtantly bedew the uterus, to which they afterwards begin to adhere by means of a mucilage that gradually gives origin to ſmall blood veſſels, as ſhall afterwards be more fully explained.

But, to return to the formation of the foetus, concerning which we have to make ſeveral remarks, both as to its ſituation, and to the different circumſtances that may prevent or alter the mode of its production.

In the human ſpecies, the ſemen of the male enters into the uterus, the cavity of which is confiderable ; and, when it meets with a fufficient quantity of female femen, the two inftantly mix, and the organic particles unite and form the foetus. The whole is, perhaps, performed in a moment, efpecially if the two fluids be in an active ftate. The cavity of the uterus is the proper place for the formation of the foetus ; becaufe the femen of the male has an eafier admiffion into the uterus than into the Fallopian tubes or ovarium ; and, as the uterus has only a fmall aperture, which is always fhut, except when opened by the ardor of love, the materials of generation remain there in fafety, unlefs they be difturbed by fome rare and accidental circumftance. But, as the male fluid moiftens the vagina, before it penetrates the uterus, and, as the organic particles are exceedingly active, it may penetrate as far as the Fallopian tubes and ovarium. In the fame manner, as the female fluid is already perfected in the glandulous bodies of the tefticles, from which it diftills and moiftens the Fallopian tubes, before it defcends into the uterus ; and, as it may efcape through the lacunae round the neck of the uterus, it is not impoffible that the mixture of the two liquors may take place in all thefe different places. Foetufes, therefore, may frequently be formed in the vagina, and inftantly fall out of it, having nothing proper for their retention. They may alfo be fometimes formed in the Fal-

lopian

lopian tubes ; but inſtances of this kind muſt be rare.

Anatomiſts mention, that foetuſes have been found, not only in the Pallopian tubes, but likewiſe in the ovaria. M. Theroude *, a ſurgeon in Paris, ſhowed to the academy a rude maſs which he found in the right ovarium of a girl of 18 years of age. Two open fiſſures, garniſhed with hair like the eye-lids, were perceived in this maſs. Above theſe eye-lids was a kind of front, with a black line in place of eye-brows. Immediately above the front, there were ſeveral hairs collected into two ſeparate pencils, one of them about ſeven inches long, and the other three. Below the angle of the eye, two large, hard, white, dentes molares appeared, together with their gums : Theſe teeth were about three lines long, and about a line diſtant from each other. Several other teeth appeared, ſituated at different diſtances. In the ſame volume †, M. Mery is reported to have found in the ovarium of a woman an upper jaw-bone, with ſeveral teeth in it, ſo perfect that they appeared to be at leaſt of ten years growth. In the Medical Journal, publiſhed by the Abbe de la Roque ‡, we have the hiſtory of a woman, who died of her ninth child, which had been formed *in* or *near* one of the ovaria ; for, from the deſcription, it is not clear whether the child was within the ovarium,

* See mem. de l'acad. des ſciences, tom. 2. p. 91.
† P. 244. ‡ January 1683.

varium, or adjacent to it only. This foetus was about an inch thick, and completely formed. In the Philoſophical Tranſactions, examples are recorded of teeth, hair, and bones being found in the ovaria of women. If all theſe facts can be credited, the ſeminal liquor of the male muſt be ſuppoſed ſometimes, though rarely, to mount up to the ovaria. But there are many conſiderations which render this point extremely doubtful: 1. The facts which ſeem to ſupport it are few: 2. The only inſtance of a perfect foetus found in the ovarium, is narrated in a very ſuſpicious manner by M. Littre. Neither is it impoſſible that the ſeminal fluid of the female alone may ſometimes produce organized maſſes, as moles, ciſts full of hair, of bones, or of fleſh. Beſides, if we are to believe anatomiſts, foetuſes may be formed in the teſticles of men as well as in thoſe of women; for, we are told by a ſurgeon, in the 2d volume of the hiſtory of the old academy *, that he found a foetus, with its membranes, in which the head, the feet, the eyes, the bones and cartilages, were diſtinguiſhable, in the ſcrotum of a man. Were all theſe facts equally worthy of credit, we muſt neceſſarily adopt one of the two following hypotheſes; either that the ſeminal fluid of each ſex can produce nothing without being mixed with the other; or, that either of the fluids alone is capable of producing irregularly organized maſſes. If we maintain the former

* Page 298.

mer hypothesis, to explain the facts above related, we shall be obliged to admit, that the male fluid sometimes ascends to the ovarium, and, by mixing there with the female fluid, forms organized bodies; and also, that the female fluid, by being copiously effused in the vagina, may, in the time of coition, penetrate as far as the scrotum of the male, in the same manner as the venereal virus often reaches that part; and, consequently, that an organized body may be formed in the scrotum by a mixture of the male and female fluids. If the other hypothesis, which is the most probable, be adopted, namely, that the seminal fluid of each individual may separately produce organized masses, then all these osseous, fleshy, and hairy bodies, which sometimes appear in the ovaria of females, and in the scrotum of males, may derive their origin from the seminal fluid of the individual in which they are found. But it is needless to speculate farther concerning facts which seem to be more uncertain than inexplicable; for I am inclined to think, that the seminal fluid of each individual may singly produce something; and that young girls, for example, may produce moles, without any intercourse with the male, in the same manner as hens lay eggs without the intervention of the cock. I might support this opinion with observations equally credible as those we have just now quoted. M. de la Saone, a physician and anatomist, published a treatise on this subject, in which

which he aſſures us, that nuns, though ſtrictly cloiſtered, ſometimes produce moles: And why ſhould this be impoſſible, ſince hens produce eggs without any communication with the cock, and ſince we find, in the cicatrices of theſe eggs, inſtead of a chicken, a mole with its appendages? The analogy here is ſufficiently ſtrong to make us at leaſt ſuſpend a raſh determination. Whatever be in this, it is certain, that a mixture of the two fluids is neceſſary for the formation of a foetus, and that this mixture cannot be properly effected but in the uterus, or in the Fallopian tubes, where anatomiſts have ſometimes diſcovered foetuſes: And it is natural to imagine, that thoſe which have been found in the cavity of the abdomen, have eſcaped by the extremity of the tube, or by ſome accidental rupture of the uterus; and that they never fall into the abdomen from the ovarium, becauſe I think it next to impoſſible that the ſeminal fluid ſhould aſcend ſo far. Leeuwenhoek has computed the motion of his pretended ſpermatic animals to be four or five inches in 40 minutes; ſo that, if the whole fluid moved at this rate, in an hour or two the animalcules might proceed from the vagina into the uterus, from the uterus into the Fallopian tubes, and from the Fallopian tubes into the ovaria. But, how is it poſſible to conceive, that the organic particles, whoſe motion ceaſes whenever they are deprived of the fluid part of the ſemen, ſhould arrive at the ovarium,

unleſs

unlefs they were accompanied with the liquor in which they fwim? The moving particles cannot give a progreffive motion to the fluid which contains them. Thus, whatever activity may be afcribed to thefe organic particles, we cannot conceive how they fhould arrive at the ovarium, and there form a foetus, unlefs, by fome unknown power, the fluid be abforbed by the ovarium, a fuppofition which is not only gratuitous, but contrary to probability.

The difficulty attending this fuppofition confirms the opinion, that the male fluid enters the uterus, either by its orifice, or by penetrating its fubftance. The female fluid may likewife find its way into the uterus, either by the aperture at the extremity of the Fallopian tubes, or by penetrating the fubftance of the tubes and uterus. M. Weitbrech, an able anatomift of the Academy of Peterfburg, has clearly proved that the feminal fluid can penetrate through the fubftance of the uterus: ‘ Res omni attentione digniffima,’ fays he, ‘ oblata mihi eft in utero foeminae alicu-
‘ jus a me diffectae; erat uterus ea magnitudi-
‘ ne qua effe folet in virginibus, tubaeque ambae
‘ apertae quidem ad ingreffum uteri, ita ut ex
‘ hoc in illas cum fpecillo facile poffem tranfire
‘ ac flatum injicere, fed in tubarum extremo nul-
‘ la dabatur apertura, nullus aditus; fimbriarum
‘ enim ne veftigium quidem aderat, fed loco il-
‘ larum bulbus aliquis pyriformis materia fubal-
‘ bida fluida turgens, in cujus medio fibra plana

‘ nervea,

'nervea, cicatriculae aemula, apparebat, quae
'sub ligamentuli specie usque ad ovarii involu-
'cra protendebatur.

'Dices, eadem a Regnero de Graaff jam
'olim notata. Equidem non negaverim illus-
'trem hunc professorem, in libro suo de organis
'mulieribus, non modo similem tubam deline-
'asse, Tab. xix. fig. 3. sed et monuisse 'tubas,
"quamvis, secundum ordinariam naturae dis-
"positionem, in extremitate sua notabilem sem-
"per coarctationem habeant, praeter naturam
"tamen aliquando claudi;' verum enimvero,
'cum non meminerit auctor an id in utraque
'tuba ita deprehenderit, an in virgine, an status
'iste praeternaturalis sterilitatem inducat, an
'vero conceptio nihilominus fieri possit, an a
'principio vitae talis structura suam originem
'ducat, sive an tractu temporis ita degenerare
'tubae possint, facile perspicimus multa nobis
'relicta esse problemata, quae, utcunque soluta,
'multum negotii facescant in exemplo nostro.
'Erat enim haec foemina maritata, viginti qua-
'tuor annos nata, quae filium pepererat quem
'vidi ipse, octo jam annos natum. Dic igitur
'tubas ab incunabulis clausas sterilitatem indu-
'cere: Quare haec nostra foemina peperit?
'Dic concepisse tubis clausis: Quomodo ovu-
'lum ingredi tubam potuit? Dic coaluisse tubas
'post partum: Quomodo id nosti? quomodo
'adeo evanescere in utroque latere fimbriae pos-
'sunt, tanquam nunquam adfuissent? Si qui-
'dem

'dem ex ovario ad tubas alia daretur via, prae-
'ter illarum orificium, unico greſſu omnes ſu-
'perarentur difficultates; ſed fictiones intellec-
'tum quidem adjuvant, rei veritatem non de-
'monſtrant; praeſtat igitur ignorationem fateri,
'quam ſpeculationibus indulgere *.' Theſe difficulties, which occurred to this acute obſerver, are inſurmountable, according to the egg-ſyſtem. But the fact he records is alone ſufficient to demonſtrate, that the female fluid may penetrate the ſubſtance of the uterus; and it is not to be doubted that the male fluid is capable of entering it in the ſame manner. The change which the male fluid produces in the uterus, and the ſpecies of vegetation or expanſion which it occaſions in that viſcus, is ſufficient to demonſtrate the truth of the fact. Beſides, the fluid which iſſues through the lacunae of De Graaff being of the ſame nature with that of the glandulous bodies, it is evident that this liquor proceeds from the ovaria; and yet there are no veſſels through which it could paſs. We muſt therefore conclude, that it penetrates through the ſpongy ſubſtance of the parts, and that it not only enters the uterus, but may even iſſue out of it, when the parts are irritated.

But, though this penetration ſhould be regarded as impoſſible, it cannot be denied, that the female fluid, which diſtills from the glandulous

* See Comm. Acad. Petropol. vol. iv. pag. 261. and 262.

lous bodies of the ovaria, may fall into the uterus, by entering the apertures at the extremities of the Fallopian tubes, as the male fluid enters by the orifice of the uterus itſelf; and, conſequently, that the foetus may be formed in the cavity of the uterus, by the mixture of the two fluids, in the manner already explained.

CHAP.

CHAP. XI.

Of the Expanſion, Growth, and Delivery of the Foetus, &c.

IN the expanſion of the foetus, two different ſpecies of growth are diſtinguiſhable: The firſt, which immediately ſucceeds the formation of the foetus, is not uniform in all the parts of the animal. The nearer the foetus approaches to maturity, the growth of the parts is more proportional; and it is not till after the birth, that all the parts grow nearly in an equable manner. We muſt not imagine, that the foetus, at the time of its formation, has the exact figure of an adult. The ſmall embryo, it is true, contains all the parts eſſential to a man; but they differ in their ſucceſſive expanſion.

In an organized body, like that of an animal, ſome parts may be ſuppoſed to be more eſſential than others; and though none of them are uſeleſs or ſuperfluous, yet there are ſome to which others ſeem to owe their growth and diſpoſition. Some parts may be conſidered as fundamental, without which the animal could not exiſt, and others as only ſuperficial and acceſſory. The latter

latter ſeem to derive their origin from the former, and to be intended more for conferring ſymmetry and external ornament on the animal, than for enabling it to exiſt, or to perform the functions eſſential to life. Theſe two different ſpecies of parts are ſucceſſively expanded, and are almoſt equally apparent at the time of birth. But there are other parts, as the teeth, which arrive not at full maturity till ſeveral years after; and others, as the glandulous bodies in the female teſticles, the beard of males, &c. which appear not till the age of puberty.

To diſcover the fundamental and eſſential parts of an animal body, attention muſt be had to the number, ſituation, and nature of the whole. Thoſe which are ſimple, thoſe whoſe poſition is invariable, and thoſe without which the animal cannot exiſt, muſt neceſſarily be the moſt eſſential. Thoſe, on the contrary, which are double, or more numerous, thoſe which vary in ſize and poſition, and thoſe which may be taken away without injuring or killing the creature, may be regarded as leſs eſſential, or more acceſſory to the animal machine. Ariſtotle mentions, that the only parts eſſential to all animals are thoſe with which they take and digeſt their nouriſhment, and throw out the ſuperfluous part of it from the body. The whole inteſtinal canal is indeed extremely ſimple, and no other part can ſupply its place. The head and back-bone are likewiſe ſimple parts, the po-

ſition

ſition of which is invariable. The back-bone is the foundation of the animal frame; and the action and movements of moſt members of the body depend upon the ſpinal marrow which that bone contains. It is this part, alſo, together with the head, which appears firſt in the embryo. Now, theſe ſimple parts, which are firſt formed, are all eſſential to the exiſtence and the form of the animal.

The double parts in an animal body are more numerous than the ſingle parts; and they ſeem to be produced on each ſide of the ſingle parts by a ſpecies of vegetation; for the double parts are ſimilar in form, and different only in poſition. The left hand is perfectly ſimilar to the right; but, if the left hand were placed in the ſituation of the right, we could not perform the ſame actions with it. The ſame thing may be obſerved of all the double parts: They are ſimilar in form, but differ in poſition, which is relative to the body of the particular animal; and, if a line were drawn, dividing the body into two equal parts, the poſition of all the ſimilar parts would tend to this line as to a centre.

The ſpinal marrow, and the vertebrae in which it is incloſed, appear to be the real axis of all the double parts of the animal body, from which they ſeem to derive their origin, and to be only proportional branches iſſuing from this trunk or common baſe; for, in the young chick, we ſee the ribs ſhooting from each ſide of the

 vertebrae,

vertebrae, as the ſmall branches ſhoot out from the principal branch of a tree. In all embryos, the middle of the head and the vertebrae firſt appear; we then ſee, on each ſide of the veſicle which compoſes the middle of the head, two other veſicles which ſeem to proceed from the firſt: Theſe two veſicles contain the eyes, and the other double parts of the head. In the ſame manner, we perceive an equal number of ſmall tubercles iſſuing from each ſide of the vertebrae, which gradually extend, and form the ribs, and other double parts of the trunk. Laſtly, the arms and legs appear like ſmall tubercles on each ſide of the trunk. This firſt growth is very different from what afterwards takes place: It is the production of parts which appear for the firſt time; the growth which ſucceeds is only an expanſion of parts already formed.

The order and ſymmetry of the double parts in all animals, their regular poſition, the equality of their extenſion and growth, and the perfect ſimilarity of their ſtructure, ſeem to indicate, that they derive their origin from the ſingle parts; that a certain force reſides in the ſingle parts which acts equally on each ſide; or, which amounts to the ſame, they are the baſes or fulcra againſt which the action of thoſe powers that produce the expanſion of the double parts is exerted; and that the action of theſe forces, both on the right and left ſides, are preciſely equal, and counterbalance each other.

Hence

Hence we may conclude, that, if there is any defect, or redundance, in the matter destined for the formation of the double parts, as the forces are equal on each side, this defect or excess must take place both in the right and left sides. If, for example, from a defect of matter, a man has but two fingers in the right hand, in place of five, the same defect will appear in the left; if, from an excess of matter, there be six fingers in the right hand, he will have the same number in the left; or, if the matter be vitiated, and produces a change in the parts of one side, the same change will appear in the other. Of this fact we have daily proofs: The parts of monsters are always deranged in a certain order and proportion. Hence Nature, even in her errors, uniformly commits the least of possible mistakes.

This harmony in the position of the double parts of animals, is likewise apparent in vegetables. The branches push out small ramifications on each side; the small nerves in the leaves are equally disposed with regard to the principal nerve; and, if the symmetry appears to be less exact in vegetables than in animals, this proceeds only from its being more various, and because its limits are more extensive, and less precise. But the same order is easily recognisable; and the single and essential parts are perfectly distinct from those which are double;

and it is evident, that the latter derive their origin from the former.

It is impoſſible to determine the form of theſe double parts before their expanſion, or in what manner they are complicated, or what figure reſults from their poſition in relation to the ſingle parts. The body of an animal, at the inſtant of its formation, unqueſtionably contains all the parts of which it ought to be compoſed: But the relative diſpoſition of theſe parts is then very different from what afterwards appears. If we examine the expanſion of a young leaf of a tree, we will find that it is plaited on each ſide of the principal nerve; and that its figure, at this time, has no reſemblance to that which it afterwards aſſumes. When we amuſe ourſelves with plaiting paper, in order to give it the form of a crown, of a boat, &c. the different plaits of the paper ſeem to have no reſemblance to the figure which reſults from their expanſion: We only perceive that the plaits are uniformly made in a certain order and proportion, and that, whatever is done on one ſide, is alſo done on the other. But, to determine the figures which may reſult from the expanſion of any given number of folds, is a problem beyond the powers of geometry. The ſcience of mathematics reaches not what immediately depends upon poſition. Leibnitz's art of *Analyſis ſitus* does not yet exiſt; though the art of knowing the relations that reſult from the poſition

tion of things would be, perhaps, more uſeful than that which has magnitude only for its object; for we have more occaſion to be acquainted with form than with matter.

In the expanſion of natural productions, the folded or plaited parts not only aſſume different poſitions, but they acquire, at the ſame time, extenſion and ſolidity. Since, therefore, we are unable to aſcertain the exact reſult of a ſimple expanſion of a folded ſigure, in which, as in folded paper, nothing takes place but a change of poſition among the parts, without any augmentation or diminution of the quantity of matter, how is it poſſible for us to judge concerning the expanſion of the compound body of an animal, in which not only the relative poſition, but likewiſe the quantity of matter in theſe parts, ſuffer conſiderable changes? We can only reaſon, therefore, on this ſubject, by drawing concluſions from the examination of objects at different periods of their expanſion.

We, indeed, perceive the chick in the egg before incubation: It ſwims in a tranſparent fluid, contained in a ſmall purſe formed by a very fine membrane in the centre of the cicatrice. But the chick is then only a particle of inanimated matter, in which no organization or determined figure can be diſtinguiſhed. We can perceive, however, that one of its extremities is the head, and the other the back-bone. The embryo, in this ſtate, ſeems to be the firſt product of fecundation, resulting from the mixture of the male and female semen. To ascertain this fact, several things require attention: When the hen has, for some days, been along with the cock, and afterwards separated from him, the eggs produced 20 days or a month after this separation, are equally fertile as those laid during her cohabitation with the male. The eggs produced at the end of this period require only the usual time of 21 days in hatching; and their embryos are equally advanced both in form and consistence. From this circumstance we might be led to imagine, that the form in which the embryo appears before incubation, is not the immediate effect of the mixture of the two seminal fluids, but that it existed in different forms during the abode of the egg in the body of the mother; for the embryo, in the form in which we see it before incubation, requires only the aid of heat in order to bring it to maturity. Now, if this form of the embryo had existed 21 days or a month before, when the egg was first impregnated, why was it not hatched by the internal heat of the mother? Why do we not find the chick completely formed in those eggs which have been impregnated 21 days before they are laid?

But this difficulty, though seemingly great, is not insurmountable. When the hen cohabits with the cock, the cicatrice of each egg, which contains the semen of the female, receives a small

quantity

quantity of the male fluid. The eggs in the ovarium of oviparous females are analogous to the glandulous bodies in the teſticles of the viviparous: The cicatrice of the egg correſponds to the cavity of thoſe glandulous bodies which contain the female ſemen; and that of the male penetrates and mixes with it. The formation of the embryo inſtantly reſults from this mixture or union of the two fluids. The firſt egg laid by the hen after her communication with the cock is fecundated, and capable of being hatched. Thoſe which ſhe is afterwards to lay were all impregnated at the ſame inſtant: But, as they want ſome eſſential parts, the production of which has no dependence on the male fluid; as they have neither the white, the membranes, nor the ſhell, the ſmall embryos contained in the cicatrices of theſe imperfect eggs, are incapable of being hatched, though aided by the internal heat of the mother. The embryo, therefore, remains in the cicatrice in the ſame ſtate in which it was firſt formed, till the egg acquires all the parts neceſſary to the growth and nouriſhment of the foetus; and it is not till after the egg has arrived at full perfection, that the expanſion of the embryo commences. This expanſion is effected by the external heat of incubation: But it is unqueſtionable, that, if the egg could be retained in the body 21 days after it was completely formed, the chick would be hatched, unleſs the internal heat of the mother

were

were too great; for the degrees of heat neceſſary for hatching eggs are very limited; and the leaſt exceſs or defect is equally fatal to this operation. The laſt eggs, therefore, laid by the hen, containing the embryos in the ſame ſtate as the firſt, prove nothing more than the neceſſity of their acquiring full perfection before they can be hatched.

It is apparent, therefore, that the ſtate of the embryo when the egg is laid by the hen, is its firſt ſtate, and that which immediately ſucceeds impregnation; that it undergoes no intermediate changes of form; and, conſequently, by tracing, as Malpighius has done, its gradual expanſion, hour after hour, we diſcover every thing that it is poſſible for us to know, unleſs we could perceive the mixture of the two fluids, and the manner in which the particles arrange themſelves during the firſt formation of the embryo.

If we reflect on this inſtantaneous fecundation of a number of eggs, which are to be laid at ſucceſſive intervals, we ſhall diſcover a new argument againſt the exiſtence of eggs in viviparous animals: For, if women contained eggs, like hens, why are not many of them fecundated at the ſame time? Why does not one impregnation give birth to a ſucceſſive race of children? And, when women conceive two or three children, why do they always come into the world at the ſame time? If theſe foetuſes were produced from eggs,

eggs, would they not ſucceed each other according to the different ſtates of perfection of the ſeveral eggs exiſting at the time of impregnation? And would not ſuperfoetations be as frequent as they are rare, and as natural as they are accidental?

It is impoſſible to trace the gradual expanſion of the human foetus, as we can that of the chick in the egg. The opportunities for obſervation are few; and all we know of this ſubject is derived from the writings of anatomiſts, ſurgeons, and accoucheurs. It is from collecting all their particular obſervations, and comparing their remarks with their deſcriptions, that the following abridged hiſtory of the human foetus has been compiled.

Immediately after the mixture of the two ſeminal fluids, it is probable that the whole materials of generation exiſt in the uterus, under the form of a ſmall globe; for we learn from anatomiſts, that, three or four days after conception, there is a ſmall globular maſs in the uterus, the greateſt diameter of which is about 6 lines, and the leaſt 4. This globe is formed by a delicate membrane, which contains a limpid liquor very like the white of an egg. We may already perceive, in this liquor, ſome ſmall fibres, which are the firſt rudiments of the foetus. Upon the ſurface of the globe there is a network of delicate fibres, which extends from one

of

of the extremities to the middle: Theſe are the firſt veſtiges of the placenta.

Seven days after conception, the lineaments of the foetus are diſtinguiſhable by the naked eye. They are, however, very imperfect, and have the appearance of a gelly almoſt tranſparent, though it has acquired ſome degree of ſolidity. The head and trunk may be eaſily diſtinguiſhed; becauſe this maſs is of an oblong figure, and the trunk is longeſt and moſt delicate. Some ſmall fibres, reſembling a plume of feathers, iſſue from the middle of the foetus, and terminate in the membrane in which it is incloſed. Theſe fibres are the rudiments of the umbilical cord.

Fifteen days after conception, the head and the moſt prominent features of the face are apparent. The noſe reſembles a ſmall elevated thread perpendicular to a line which marks the diviſion of the lips: Two ſmall black points repreſent the eyes; and we ſee two holes in place of ears. The body of the foetus has alſo acquired ſome growth. On each ſide of the ſuperior and inferior parts of the trunk, thoſe ſmall protuberances appear, which are the rudiments of the arms and legs. The length of the whole body is about five French lines.

Eight days after, in all three weeks, the body of the foetus is augmented only about a line: But the arms and legs are apparent. The growth of the arms is quicker than that of the legs;

legs; and the fingers ſeparate ſooner than the toes. The internal organization now begins to be viſible: The bones appear like fine threads. The ribs are diſpoſed on each ſide of the backbone like minute threads: The arms, the legs, the fingers and toes, are alſo repreſented by ſimilar threads.

At one month, the foetus is more than an inch in length: It naturally aſſumes a curved poſture in the middle of the liquor that ſurrounds it; and the membranes in which the whole is included, are both augmented and thickened. The whole maſs is of an oval figure, the greateſt diameter of which is about an inch and a half, and the leaſt about an inch and a quarter. The human figure is no longer equivocal: All the parts of the face are already diſtinguiſhable; the body is delineated; the haunches and the belly are prominent; the hands and legs are formed, and their fingers and toes are divided; the ſkin is thin and tranſparent; the viſcera reſemble a knot or plexus of fibres; the veſſels are like fine threads, and the membranes are extremely delicate: The bones are ſtill ſoft, and it is in a few places only that they have begun to aſſume ſome degree of ſolidity. The veſſels which form the umbilical cord lie parallel to each other in a ſtraight line. The placenta now occupies only a third of the whole maſs, inſtead of a half, which it did during the firſt days; the ſuperficial growth of the placenta, therefore,

therefore, has not been ſo great as that of the foetus and maſs; but it has received a great augmentation in ſolidity; it has become proportionally thicker than the membranes of the foetus, both of which are now diſtinguiſhable.

According to Hippocrates, the male foetus expands ſooner than the female.

At the end of ſix weeks, the foetus is about two inches long, and the human form begins to be more perfect, only the head is very large in proportion to the other parts of the body. About this time the motion of the heart becomes viſible: In 50 days, the heart has been perceived to beat for a conſiderable time after the foetus was extracted from the uterus.

In two months, the foetus is more than two inches in length; and the oſſification is perceptible in the middle of the two arm-bones, in the thigh and leg, and in the point of the under jaw, which is then greatly advanced before the upper. Theſe, however, are only oſſeous points. But, by means of a quicker growth, the clavicles are entirely oſſified: The umbilical cord is formed, and the veſſels which compoſe it begin to twiſt like the threads of a rope: But this cord is very ſhort in compariſon of the length it afterwards acquires.

In three months the foetus is nearly three inches long, and weighs about three ounces. Hippocrates aſſerts, that at this time the motions of the male foetus begin to be felt by the mother;

ther; but that thoſe of the female are not perceptible till four months. Some women, however, affirm that they have felt the motions of the foetus at the beginning of the ſecond month. It is difficult to acquire any certain knowledge on this ſubject: The ſenſations excited by the firſt movements of the foetus depend more, perhaps, on the ſenſibility of the mother, than the ſtrength of the child.

Four months and a half after conception, the length of the foetus is from ſix to ſeven inches. All the parts are greatly augmented, and eaſily diſtinguiſhable from each other: Even the nails appear on the fingers and toes. The teſticles of the male are ſhut up in the belly above the kidneys. The ſtomach is filled with a thick fluid, ſimilar to that which is contained in the amnios. In the ſmall guts we find a milky fluid, and a black liquid matter in the great guts. There is a ſmall quantity of bile in the veſica fellis, and a little urine in the bladder. As the foetus floats freely in the fluid that ſurrounds it, there is always ſome ſpace beween its body and the membranes in which it is contained. Theſe membranes, at firſt, grow more rapidly than the foetus; but, after a certain time, the reverſe takes place. Before the end of the third month, the head is bent forward; the chin reſts on the breaſt; the knees are elevated, and the legs folded back upon the thighs. One of the hands, and often both, touch the face. Afterwards, when

when the foetus acquires more ſtrength, it perpetually changes its poſition, as we learn from the following obſervations made by perſons ſkilled in the art of midwifery: 1. The umbilical cord is often twiſted round the body and members of the child, in a manner that neceſſarily ſuppoſes different motions and poſitions. 2. Mothers feel the motion of the child ſometimes on one ſide of the uterus, and ſometimes on the other; and it often ſtrikes againſt many different places, which could not happen unleſs it aſſumed different poſitions. 3. As the foetus ſwims in a fluid which ſurrounds it on all ſides, it may eaſily turn, extend, and twiſt itſelf by its own powers: It muſt likewiſe take different ſituations, according to the various attitudes of the mother's body; when the mother, for example, lies down, the poſition of the foetus muſt differ from what it is when ſhe ſtands.

Moſt anatomiſts maintain, that the foetus is obliged to bend its body, becauſe it is too much confined by the membranes. But this opinion ſeems not to be well founded; for, during the firſt five or ſix months, at leaſt, there is room more than ſufficient to admit a full extenſion of the foetus; and yet, during all this period, the foetus is bended. We ſee likewiſe that the chick is bended in the liquor of the amnios, while, at the ſame time, this membrane, and the fluid it contains, afford room ſufficient to hold a body five or ſix times larger than the foetus. We

may,

may, therefore, conclude, that the bended poſture of the foetus is natural, and not the effect of reſtraint. I am inclined to think, with Harvey, that the foetus takes this poſture, becauſe it is moſt favourable to reſt and ſleep; for all animals bend their bodies when they want to repoſe themſelves, or to ſleep: And, as the foetus ſleeps almoſt continually, it naturally aſſumes this advantageous poſition. 'Certe,' ſays this celebrated anatomiſt, 'animalia omnia, dum 'quieſcunt et dormiunt, membra ſua ut plurimum adducunt et complicant, figuramque ovalem ac conglobatam quaerunt: Ita pariter 'embryones, qui aetatem ſuam maxime ſomno 'tranſigunt, membra ſua poſitione ea qua plaſ'mantur (tanquam naturaliſſima ac maxime in'dolenti quietique aptiſſima) componunt *.'

The uterus, as formerly remarked, grows very quickly after pregnancy; and it continues to increaſe proportionally with the foetus. But the growth of the foetus at laſt exceeds that of the uterus; and it is natural to think, that the foetus, when near maturity, is too much confined, and agitates the uterus by repeated motions. The mother feels theſe ſucceſſive efforts, which are called periodic pains, after the labour of child-bearing commences. The more force the foetus exerts in order to dilate the uterus, it finds an increaſed reſiſtance from the natural elaſticity of the parts. Hence every effort

* Harvey de Generat. p. 257.

fort tends to open the os tincae, or orifice of the uterus, which has already been gradually enlarged during the laſt months of pregnancy. The head of the foetus puſhes along againſt the margins of this orifice, and dilates it by a conſtant preſſure, till the moment of delivery, when it opens ſo wide as to allow a free paſſage to the child.

What renders it probable that the labour-pains are occaſioned by the dilatation of the os tincae is, that this dilatation is the only certain mode of diſtinguiſhing the real from the falſe pains. Women often feel very briſk pains, which are not thoſe that immediately precede delivery. To diſtinguiſh thoſe falſe from the true pains, Deventer adviſes the accoucheur to feel the orifice of the uterus, and maintains, that, if the pains be true, the dilatation will augment upon the acceſſion of every pain; and that, on the contrary, if the pains be falſe, the orifice will rather contract than dilate, or, at leaſt, that it will not continue to dilate. Hence we may conclude, that theſe pains proceed not from a forced dilatation of the orifice of the uterus. The only thing that is embarraſſing, is the alternation of pain and of eaſe experienced by the mother. This circumſtance does not perfectly correſpond with the cauſe we have aſſigned; for the gradual and continued dilatation of an orifice ſhould produce a conſtant pain, without any intervals of eaſe. Perhaps the alternations

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may be aſcribed to to the ſeparation of the placenta: It adheres to the uterus by the inſertions of a number of ſmall papillae. May we not, therefore, ſuppoſe that theſe papillae ſeparate not from their cavities all at once; and that the ſucceſſive ſeparation of theſe papillae gives riſe, at different intervals, to the freſh acceſſions of pains? Here the effect perfectly correſponds with the cauſe; and this conjecture may be ſupported by another remark: Immediately before delivery, there iſſues out a viſcous whitiſh liquor, ſimilar to that which flows from the papillae of the placenta, when torn from the uterus. It is therefore extremely probable, that this liquor, which iſſues from the uterus, is produced by the ſeparation of ſome of the papillae of the placenta.

It ſometimes happens, that the foetus eſcapes from the uterus without burſting the membranes, and, conſequently, without diſcharging the liquor they contain. This ſpecies of birth ſeems to be the moſt natural, and is ſimilar to that of moſt animals. The human foetus, however, commonly pierces the membranes, by the reſiſtance it meets with at the orifice of the uterus: And ſometimes a part of the amnios, and even of the chorion, is brought away adhering to the head of the child like a cap. As ſoon as the membranes are pierced or torn, the liquor, which is called the *waters*, runs out, and, by lubricating the vagina and orifice of the uterus, facilitates the paſſage of the child. After the

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difcharge of the waters, there is fufficient room left in the uterus for the midwife to return the child, when its pofition is unfavourable to the birth. After the child comes into the world, the delivery is not completed. The placenta and membranes ftill remain in the uterus; and the child is attached to them by means of the umbilical cord: They are eafily brought away by the hand of the midwife; and fometimes the weight of the child is fufficient. Thefe organs, which were neceffary to the exiftence of the foetus, become ufelefs, and even noxious to the child, after birth. They are, therefore, inftantly difengaged from the child's body, by cafting a knot on the umbilical cord, about an inch from the navel, and by cutting the cord an inch above the ligature. In fix or feven days, the remains of the cord dry up, and fall off clofe to the navel.

By examining the foetus before birth, we are enabled to form fome ideas concerning the mechanifm of its natural functions. There are organs neceffary to it while in the womb of the mother, but which become ufelefs immediately after birth. The better to comprehend thefe functions, we muft explain more fully the nature of thefe acceffory parts, the umbilical cord, the membranes, with the liquor they contain, and the placenta. The umbilical cord, which is attached to the body of the foetus at the navel, is compofed of two arteries and a vein: By thefe theſe the courſe of the circulation is lengthened; but the vein is larger than the arteries. At the extremity of the cord, each of theſe veſſels divide into an infinite number of ramifications, and extend themſelves between two membranes. They ſet off from the common trunk in ſuch a manner, that the whole ramifications aſſume a round form, and are diſtinguiſhed by the name of placenta, becauſe they reſemble a cake. The central part of the placenta is thicker than its edges: Its mean thickneſs is about an inch, and its diameter is eight or nine inches, and ſometimes more. Its external ſurface, which is applied to the uterus, is convex, and the internal ſurface is concave. The blood of the foetus circulates in the cord and in the placenta. The arteries of the cord proceed from two large arteries in the foetus, and carry the blood through all the arterial ramifications of the placenta; and the blood is collected and returned to the foetus by the venous branches of the placenta and the umbilical vein.

The concave ſurface of the placenta is covered with the chorion: Its convex ſurface is alſo covered with a ſoft membrane, which ſeems to be a continuation of the chorion, and is eaſily torn; and the foetus is incloſed in the double covering of the chorion and amnios. The figure of the whole is globular, becauſe the intervals between the foetus and membranes are filled with a tranſparent fluid. This liquor is immediately confined by the amnios, which is the internal membrane: It is thin and tranſparent, and folds itſelf round the umbilical cord, at its inſertion into the placenta, and continues to cover it the whole way to the navel of the foetus. The chorion is the external membrane; it is thick, ſpongy, and interſperſed with blood-veſſels. It conſiſts of ſeveral coats, the outermoſt of which covers the convex ſurface of the placenta. It ſends off duplicatures to cover the papillae, which are inſerted into the cavities at the fundus of the uterus, called *lacunae*. Theſe inſertions connect the foetus to the uterus.

Some anatomiſts have maintained, that the human foetus, like thoſe of certain quadrupeds, was furniſhed with an *allantois*, a membrane deſtined for the reception of the urine; and they have pretended to have diſcovered it between the chorion and amnios, or in the middle of the placenta, at the root of the umbilical cord, under the form of a pretty large bladder; and that it received the urine by means of a long tube, which made a part of the cord, and which opened at one end into the bladder, and, at the other, into the allantois, anſwering the ſame purpoſes as the urachus in other animals. They acknowledge, however, that the urachus of the human foetus is not near ſo large as in quadrupeds; but they aſſert that it is divided into a number of ſmall tubes, and that the urine paſſes into their cavities.

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To theſe facts are oppoſed the experience and obſervation of moſt anatomiſts. They ſeldom find any veſtiges of an allantois either between the chorion and amnios, or in the placenta; nor do they perceive any urachus in the umbilical cord. A kind of ligament, indeed, runs from the external ſurface of the bottom of the bladder to the navel; but, when entering the cord, it becomes ſo delicate as to be almoſt reduced to nothing. Neither is this ligament commonly hollow; and we can perceive no correſponding aperture in the bottom of the bladder.

The foetus has no communication with the open air; and the experiments made upon the lungs demonſtrate that they have never reſpired; for they ſink in water, while thoſe of infants, who have breathed, uniformly ſwim: The foetus, therefore, has no reſpiration in the womb of the mother; conſequently, it can make no ſound with its voice; and all the ſtories of children groaning and crying before birth muſt be regarded as fabulous. After the waters run off, however, the air may find admiſſion into the cavity of the uterus, and the child may begin to reſpire before its birth. In this caſe, the child may cry, in the ſame manner as the chicken cries before the ſhell of the egg is broken, which it is enabled to do by means of the air lodged in a cavity between the external membrane and the ſhell: This air exiſts in all eggs, and is produced by the fermentation of the matters they contain *.

The lungs of the foetus, having no motion, receive no more blood than is ſufficient for their nouriſhment and growth: Another paſſage, therefore, is open for its circulation. The blood in the right auricle of the heart, inſtead of paſſing into the pulmonary artery, and, after circulating through the lungs, returning into the left auricle by the pulmonary vein, paſſes directly from the right to the left auricle, through an aperture called the *foramen ovale*, which is in the partition of the heart that ſeparates the two auricles: The blood then enters the aorta, by the ramifications of which it is diſtributed to every part of the body; it is then taken up by the numerous branches of the veins, which gradually unite into one trunk, called the *vena cava*, that terminates in the right auricle of the heart. The blood contained in this auricle does not all paſs through the foramen ovale; part of it eſcapes into the pulmonary artery, but it enters not into the body of the lungs; for there is a communication between the pulmonary artery and the aorta, by an arterial canal which leads immediately from the one to the other. It is by theſe means that the blood circulates in the foetus, without entering the lungs, which it does in children, in adults, and in all animals who reſpire.

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* See Vegetable Statics, chap. 6.

It has been imagined by ſome, that the blood of the mother paſſes into the body of the foetus, by means of the placenta and umbilical cord: They ſuppoſed, that the blood-veſſels of the uterus opened into the lacunae, and thoſe of the placenta into the papillae, and that they inoſculated with one another. But this opinion is contradicted by experiment. When the arteries of the umbilical cord are injected, the liquor returns by the veins, without any of it eſcaping externally. Beſides, the papillae can be drawn out of the lacunae in which they are lodged, without any extravaſation of blood either from the uterus or placenta; from both there oozes out a milky matter, which, we have already remarked, ſerves for the nouriſhment of the foetus. It is probable that this liquor enters the veins of the placenta in the ſame manner as the chyle enters the ſubclavian vein; and the placenta, perhaps, performs the office of the lungs in maturating the blood. One thing is certain, that the blood appears much ſooner in the placenta than in the foetus; and I have often obſerved, in eggs which had been ſat upon for a day or two, that the blood appeared firſt in the membranes, and that their blood-veſſels are numerous and large, while the whole body of the foetus, except the point where theſe blood-veſſels terminate, is only a white tranſparent matter, in which there is not the leaſt veſtige of blood.

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It has been imagined that the liquor of the amnios is a nouriſhment received by the mouth of the foetus. Some have even pretended to have found this liquor in the ſtomach, and to have ſeen ſeveral foetuſes who wanted the umbilical cord entirely, and others who had only a ſmall portion of it, which had no connection with the placenta. But, in this caſe, may not the liquor have paſſed into the body of the foetus by the portion of the cord that remained, or even by the navel itſelf? Beſides, other facts may be oppoſed to theſe: Foetuſes have been found, whoſe lips were not ſeparated; and others whoſe oeſophagus had no aperture. To reconcile theſe facts, ſome anatomiſts have maintained, that the aliment paſſed into the foetus partly by the umbilical cord, and partly by the mouth. But none of theſe opinions ſeem to have any foundation. The queſtion is not, how the foetus alone, but how the whole apparatus of generation, receive their growth and nouriſhment? for the placenta, the liquor, and the membranes, increaſe in bulk as well as the foetus; and, conſequently, thoſe inſtruments and canals employed for receiving and tranſporting nouriſhment to the foetus, are themſelves endowed with a ſpecies of life. The expanſion of the placenta and membranes is equally difficult to conceive as that of the foetus; and, it may be ſaid, with equal propriety, that the foetus nouriſhes the placenta, as that the placenta nouriſhes

nouriſhes the foetus. At the commencement of growth, the whole maſs floats in the uterus, without any adheſion; and, of courſe, the nouriſhment can only be conveyed by an abſorption of the lacteous fluid contained in the uterus. The placenta appears firſt to attract this fluid, which it converts into blood, and tranſports by the veins into the foetus. The *liquor amnii* ſeems to be nothing but this milky fluid in a purified ſtate, the quantity of which is augmented, by a ſimilar abſorption, in proportion to the growth of the membranes; and the foetus probably abſorbs this liquor, which ſeems to be neceſſary for its growth and nouriſhment: For, it is worthy of remark, that the foetus, during the firſt two or three months, contains very little blood: It is as white as ivory, and appears like a congeries of lymph ſomewhat conſolidated; and, as the ſkin is tranſparent, and all the parts extremely ſoft, the body of the foetus may be eaſily penetrated by the fluid in which it ſwims, and thus receive the matter neceſſary for its growth and expanſion. It may indeed be ſuppoſed that the foetus afterwards receives nouriſhment by the mouth; becauſe we find a liquor, ſimilar to that of the amnios, in the ſtomach, urine in the bladder, and meconium, or excrement, in the inteſtines; and, as neither urine nor meconium appear in the amnios, it is natural to conclude, that no excrements are voided by the foetus, eſpecially as ſome are born without having the

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anus perforated, and yet large quantities of meconium are found in their inteſtines.

Though the foetus has no immediate connection with the uterus, but is only attached to it by the ſmall external papillae of the placenta; though it has no communication with the blood of the mother, but, in ſome meaſure, is equally independent of her as the egg is independent of the hen which covers it; yet it has been maintained, that, whatever affects the mother, produces a ſimilar effect upon the foetus, and that the impreſſions received by the former are communicated to the ſenſorium of the latter. To this imaginary influence have been attributed all thoſe reſemblances, monſtroſities, and peculiar marks which appear on the ſkin of particular children. Many of theſe marks I have examined, and they uniformly appeared to be occaſioned by a derangement in the texture of the ſkin only. Every mark muſt neceſſarily have a faint reſemblance to ſomething or other: But ſuch reſemblances, I am perſuaded, depend more on the imagination of thoſe who ſee them, than upon that of the mother. On this ſubject, the marvellous has been puſhed to an extreme degree. The foetus has not only been ſaid to bear the real repreſentations of the appetites of the mother, but that, by a ſingular ſympathy, the marks which repreſent ſtrawberries, cherries, &c. aſſumed a deeper colour during the ſeaſon of theſe fruits. A little attention, however, will convince

convince us, that theſe changes of colour are more frequent, and that they happen whenever the motion of the blood is accelerated, whether it be occaſioned by the heat of ſummer, or by any other cauſe. The marks are always either yellow, or red, or black; becauſe the blood gives theſe colours to the ſkin when it enters in too great quantities into the veſſels. If theſe marks were occaſioned by the appetites of the mother, why are not their forms and colours as various as the objects of her deſires? What a multitude of ſtrange figures would be exhibited, if all the whimſical longings of a mother were written upon the ſkin of the child?

As our ſenſations have no reſemblance to the objects which excite them, it is impoſſible that deſire, fear, horror, or any other paſſion or emotion, can produce real repreſentations of the objects by which they are occaſioned. An infant being, in this reſpect, equally independent of the mother as the egg is independent of the hen that ſits upon it, I ſhould be equally induced to believe that the imagination of a hen, which ſaw by accident a cock's neck twiſted, ſhould produce wry necked chickens from the eggs ſhe was hatching, as that a woman that ſaw a man broke upon the wheel, ſhould produce, by the mere force of imagination, a child with all its limbs broken.

But, ſuppoſing this fact to be well atteſted, I ſtill maintain that the imagination of the mother could

could not be the caufe of it: For, what is the effect of horror? An internal movement, or, if you pleafe, a convulfion of the mother's body, which might alternately comprefs and ftretch the uterus. What would be the refult of this commotion? Nothing fimilar to its caufe; for, if the commotion was very violent, the foetus might be killed, wounded, or have fome of its parts deranged: But how is it poffible to imagine that this commotion fhould produce in the foetus any thing fimilar to the thoughts of the mother, unlefs we fuppofe, with Harvey, that the uterus poffeffes the faculty of conceiving ideas, and of realifing them upon the foetus?

But, if the imagination of the mother has no effect upon the foetus, it may ftill be demanded, Why did this child come into the world with its members broken? Though a direct folution of a fact, which is both extraordinary and uncertain, is not to be expected; yet, I think, this queftion admits of a fatisfactory anfwer. Phaenomena of the moft uncommon kind, and which are but rarely exhibited, as neceffarily happen as thofe that are ufual and frequent. Among the infinite combinations of which matter is capable of forming, arrangements of the moft peculiar and extraordinary fpecies muft fometimes take place. Hence, out of the numberlefs children which daily come into the world, one may fometimes appear with two heads, with four legs, or with all its members broken. It is, therefore,

therefore, within the circle of nature, that a child, without the aid of the mother's imagination, may be born with its arms and legs broken. This phaenomenon may have been exhibited oftener than once; the mother of this child may, during her pregnancy, have ſeen a man broken on the wheel; and the defects of conformation in the child may have been attributed to the impulſe made, by this dreadful ſpectacle, upon the imagination of the woman. But, independent of this general ſolution, the fact may be explained in a more direct manner. The foetus, as formerly remarked, has nothing in common with the mother. Its functions, its organs, its blood, its movements, are all peculiar, and belong to itſelf alone. The only matter it derives from the mother, is the liquor or nutritive lymph which diſtills from the uterus. If this lymph ſuffers any change, if it be infected with the venereal virus, the infant is affected with the ſame diſeaſe; and it is reaſonable to think that all the diſeaſes which proceed from vitiated humours may be communicated from the mother to the child. We know that the ſmall pox is communicated in this manner; and we have too many examples of children, immediately after birth, becoming innocent victims of the debauchery of their parents. The venereal virus attacks the moſt ſolid parts of the bones; and it appears to act with more force upon the middle of the bones, which is the part where the oſſification offification firft commences, and is, of courfe, the moft hard and folid part. I conceive, therefore, that the infant in queftion has been affected with the venereal diforder while in the womb of its mother, and that this was the reafon why it came into the world with its bones broken through the middle.

The fame effect might be produced by the rickets: In the royal cabinet, there is a fkeleton of a rickety child, the bones of whofe legs and arms are joined in the middle by a callus: From infpecting this fkeleton, it appears that its bones had been broken before birth, and afterwards reunited by a callus.

But we have dwelt too long upon a fact which credulity alone has rendered marvellous. Prejudice, efpecially that fpecies of it which is founded in wonder, will always triumph over reafon. It is needlefs to attempt to perfuade women that the marks on their children have no connection with their ungratified longings. I have fometimes afked them, before the birth of a child, of what particular longings they had been difappointed, and, of courfe, what marks the child would bear? But I had only the fatisfaction of perplexing, without convincing them.

The time of geftation is generally about nine months, but it is fometimes longer and fometimes fhorter. Many children are born in the feventh and eighth, and fome not till after the ninth month: But, in general, the births before the

the ninth month are more frequent than thoſe which exceed that term.

It is generally believed, that children born in the eighth month cannot live, or, at leaſt, that more of them die than of thoſe who come into the world in the ſeventh month. This opinion appears to be paradoxical; and, if we conſult experience, I believe it will be found to be erroneous. A child born in the eighth month is more perfectly formed, and conſequently more vigorous and lively, than one who is born in the ſeventh. This opinion, however, is very commonly received, and is founded on the authority of Ariſtotle: 'Caeteris animantibus ferendi 'uteri unum eſt tempus, homini vero plura ſunt; 'quippe et ſeptimo menſe et decimo naſcitur, 'atque etiam inter ſeptimum et decimum poſitis; 'qui enim menſe octavo naſcuntur, *etſi minus*, 'tamen vivere poſſunt *.' The beginning of the ſeventh month is the earlieſt term of delivery. If the foetus be rejected ſooner, it dies, and is denominated an abortion. Thus the time of geſtation is more various in the human ſpecies than in other animals; for it extends from the 7th to the 10th, and, perhaps, to the eleventh month.

We are aſſured by women who have had many children, that females remain longer in the womb than males. If this be true, it is not ſurpriſing that female children ſhould ſometimes be born

* Vide de Generat. anim. l. 4. c. ult.

born in the 10th month. When infants come into the world before the 9th month, they are neither ſo large nor ſo well formed as thoſe who appear not till a later period. Thoſe, on the contrary, who remain in the womb till the 10th month, are larger and better made; their hair is longer; the growth of the teeth, though ſtill concealed within the gums, is more advanced; and the tone of their voice is deeper and more diſtinct.

With regard to the occaſional cauſes of delivery, there is much uncertainty. It is imagined by ſome writers, that, when the foetus has acquired a certain ſize, the capacity of the uterus becomes too ſmall for its retention, and that the reſtraint felt by the child obliges it to exert every effort to break its priſon. Others alledge, which amounts nearly to the ſame thing, that the foetus becomes too heavy to be ſupported by the uterus, which, therefore, opens to be diſcharged of its load. Neither of theſe reaſons appear to be ſatisfactory: The uterus has always ſufficient capacity and ſtrength to contain and ſupport the weight of a child of nine months; for it is often loaded with two, during the ſame period; and it is certain, that the weight and ſize of two children of eight months, for example, exceed thoſe of a ſingle infant of the ſame age. Beſides, it is not unfrequent that a child of nine months is leſs than another at eight months, though it ſtill remains in the womb.

Galen

Galen pretends that the foetus continues in the uterus till it is able to take nouriſhment by the mouth, and that the want of proper food makes it reſtleſs, and anxious to eſcape. It has been ſaid by others, that the foetus is originally nouriſhed by the mouth, but that, in proceſs of time, the liquor amnii is ſo contaminated with the urine and tranſpiration of the foetus, that it becomes perfectly diſguſtful, and obliges the child to uſe every method to effect its eſcape from the womb.

Theſe reaſons ſeem not to be more ſatisfactory than the former; for from them it would follow, that the ſmalleſt and weakeſt foetuſes would neceſſarily remain longer in the womb than thoſe of larger and more robuſt bodies; which is by no means the caſe. Beſides, it is not for nouriſhment that the child, immediately after birth, ſeems to be anxious; for it can want food for a conſiderable time after: It appears, on the contrary, to be extremely deſirous of eaſing itſelf of the ſuperfluous load of nouriſhment (the meconium) received in the womb. This circumſtance induced Drelincourt, and ſome other anatomiſts, to think, that the acrimony and uneaſineſs, ariſing from an accumulation of excrement in the bowels, is the reaſon why they become reſtleſs, and uſe every effort to eſcape from the womb. I am not, I acknowledge, more ſatisfied with this explication than the others. If the child is preſſed with faeces, why does it not evacuate them in the liqour amnii? But this never happens. It appears, on the contrary, that the neceſſity of evacuating the meconium is not felt till after birth, when the motion of the diaphragm, occaſioned by reſpiration, compreſſes the inteſtines, and gives riſe to this evacuation; eſpecially ſince no meconium was found in the amnios of a foetus of ten months, who had not reſpired, and ſince an infant of ſix or ſeven months diſcharges the meconium ſoon after reſpiration.

Other anatomiſts, and particularly Fabricius ab Aquapendente, imagined that the foetus left the uterus, from a deſire of being refreſhed by reſpiration. But this cauſe ſeems to be as chimerical as any that has been mentioned. It is impoſſible that a foetus can have any idea of reſpiration; and far leſs can it have any conception whether reſpiration would be agreeable or diſagreeable.

After conſidering all theſe hypotheſes, I ſuſpect that the delivery of the foetus depends on a cauſe of a very different nature. The menſtrual flux returns at ſtated intervals. Though its appearance be interrupted by impregnation, its cauſe is not deſtroyed; and, though no blood is exhibited at the accuſtomed period, yet a revolution in the ſyſtem, ſimilar to what happens before impregnation, muſt take place. It is for this

this reaſon, that, in ſome women, the menſes are not entirely ſuppreſſed during the firſt two or three months after conception. I imagine, therefore, that this periodic revolution happens as regularly after a woman has conceived as before, but that the blood is prevented from flowing, becauſe the excretories of the uterus are ſwelled and ſhut up, unleſs when it arrives in ſuch large quantities, and acts with ſuch force, as to overcome the reſiſtance with which it is oppoſed. In this caſe, a great quantity of blood ruſhes out, and an abortion is the conſequence. But it frequently happens, that a ſmall quantity of blood appears, without producing this effect; becauſe the blood has only been able to open a few of the canals or excretories of the uterus, while the reſt remain entirely obſtructed.

Though no blood appears, which is generally the caſe, the firſt revolution fails not to be accompanied with the ſame painful ſymptoms. During the firſt ſuppreſſion of the menſes, therefore, the uterus is affected with a conſiderable agitation, which, when a little augmented, entirely deſtroys the product of generation. Hence we may reaſonably conclude, that few of thoſe conceptions, which happen a ſhort time before the accuſtomed return of the menſes, are ſucceſsful; becauſe the action of the menſtrual blood eaſily deſtroys the feeble roots of a germ ſo tender and ſo delicate. Thoſe conceptions, on the contrary, which take place immediately after this periodic difcharge, fucceed much better; becaufe the foetus is allowed more time to grow, and to fortify itfelf againft the action of the blood, when the next revolution happens in the fyftem.

After the foetus has been enabled to refift the action of the firft revolution, the increafe of its growth, and of its attachment to the uterus, render it ftill more capable of refifting any of the fubfequent revolutions: Abortions, indeed, fometimes happen during every revolution; but they are more rare in the middle of the period of geftation than either at the beginning or near the end. Why they are more frequent at the beginning, has already been explained: It only remains to fhow why they are likewife more frequent towards the end.

The foetus generally comes into the world during the tenth revolution of the menfes. When it is born at the ninth or eighth, it lives, and is not, therefore, regarded as an abortion. Some have pretended to have feen inftances of children born at the feventh, and even at the fixth revolution, who, notwithftanding this unfavourable circumftance, continued to live. There is no difference between abortion and birth, but what relates to the living powers of the child. In general, the number of abortions in the firft, fecond, and third months, for the reafons already affigned, is very great; and the number of premature births, in the feventh and eighth months,

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is alſo very great, in proportion to the abortions in the fourth, fifth, and ſixth months; becauſe, during this middle term of geſtation, the product of generation having acquired ſtrength and ſolidity ſufficient to reſiſt the action of the firſt four periodic revolutions, a more violent effort than any of the former is neceſſary to deſtroy the foetus. For the ſame reaſon, an abortion is more difficult during the fifth and ſixth months. But the foetus, which till now was weak, and could exert its own force only in a feeble manner, begins to move with more vigour; and, when the eighth revolution takes place, the efforts of the foetus uniting with thoſe of the uterus, and facilitating its excluſion, the foetus may come into the world in the ſeventh month, and be in a capacity of living, whenever it happens to be unuſually ſtrong at this period. But, if the foetus be excluded ſolely from a weakneſs of the uterus, which renders it unable to reſiſt the action of the blood during the eighth revolution, the birth of it is conſidered as an abortion, and the child dies. But ſuch caſes are uncommon; for, if the foetus has reſiſted the firſt ſeven revolutions, nothing but particular accidents can prevent it from reſiſting the eighth, unleſs it has acquired more vigour than is common at this period. A foetus which has acquired the ſame degree of ſtrength, but at a later period, will be excluded at the ninth revolution; and thoſe which require nine months in obtaining this degree of ſtrength, will be born at the tenth revolution, which is the moſt uſual term. But, when the foetus acquires not this degree of ſtrength and perfection in nine months, it will remain in the uterus till the eleventh, or even the twelfth revolution, that is, till the tenth or eleventh month: Of ſuch late births many examples are recorded.

Other reaſons, to confirm the opinion, that the menſtrual flux is the occaſional cauſe of births at different periods, may be produced. The females of all animals which have no menſes bring forth very nearly at the ſame terms: The difference in the times of geſtation is extremely ſmall. We may, therefore, conclude, that this variation, which is very great in women, proceeds from the action of the menſtrual blood, which is exerted at every periodic revolution.

We have already remarked, that the placenta adheres to the uterus by the papillae only; that there is no blood either in theſe papillae, or in the lacunae in which they are inſerted; and that, when they are ſeparated, an operation which requires no great effort, a milky liquor only iſſues from them. Why, therefore, is the birth of a child uniformly followed by a conſiderable haemorrhage, firſt of pure blood, and afterwards of blood mixed with a watery fluid? This blood proceeds not from the ſeparation of the placenta; for the papillae are drawn out of the lacunae without

without any effuſion of blood. Delivery, therefore, which is nothing more than this ſeparation, ought to produce no haemorrhage. Is it not more natural, on the contrary, to think, that the action of the blood is the cauſe of the birth; and that it is this menſtrual blood alone which forces the veſſels of the empty uterus, and begins to flow immediately after delivery, in the ſame manner as it did before conception?

We know, that, for ſome time after conception, the ſac which contains the product of generation, adheres not to the uterus. We have ſeen, from the experiments of De Graaff, that, by blowing upon the ſmall globule, it changes its poſition. The adheſion to the uterus is never very ſtrong: In the early periods of geſtation, the placenta is ſlightly applied to the uterus; and theſe parts are only contiguous, or joined by a mucilaginous matter, which has hardly any adheſion. How, then, ſhould it happen, that, in abortions of the firſt or ſecond month, this globule never eſcapes without being attended with a great effuſion of blood? This effuſion cannot be occaſioned by the paſſage of the globule, which has no adheſion to the uterus. It is by the action of the blood, on the contrary, that the globule is extruded. Should we not, therefore, conclude, that this is the menſtrual blood, which, by forcing the canals through which it was accuſtomed to flow before impregnation,

nation, deſtroys the product of conception, and reſumes its ordinary courſe?

The pains of child-bearing are principally occaſioned by this action of the blood; for, it is well known, that they are equally violent in abortions of two or three months, as in ordinary births; and that many women feel, without having conceived, very acute pains, whenever the menſtrual flux is about to appear. Theſe pains are of the ſame kind with thoſe which accompany abortions or births. Ought we not, therefore, to aſcribe them to the ſame cauſe?

It appears, then, that the periodic revolution of the menſtrual blood has great influence in child-bearing, and that it is the cauſe why the terms of delivery in women are more various than in other animals which are not ſubject to this diſcharge, and which always bring forth at the ſame times. It is alſo apparent, that the revolution occaſioned by the action of the menſtrual blood is not the only cauſe of birth: The action of the foetus itſelf contributes greatly to this end; for there are inſtances of children having made their eſcape from the uterus after the death of the mother, which could only happen from an exertion peculiar to the foetus.

The terms of geſtation in cows, ſheep, and other animals, are always the ſame, and no haemorrhage attends their delivery. May we not, therefore, conclude, that the blood diſcharged by women after delivery is the menſtrual

blood,

blood, and that the action of this blood upon the uterus, during every periodic revolution, is the reaſon why the human foetus is excluded at ſo many different terms? It is natural to imagine, that, if the females of viviparous animals had menſes like women, their deliveries would be followed by an effuſion of blood, and be equally various in their terms. The foetuſes of animals are brought forth covered with their membranes; and it is ſeldom that the membranes are broken, or the waters flow before delivery. But the birth of a child, with its membranes entire, is a rare phaenomenon. This circumſtance ſeems to evince, that human foetuſes make greater efforts to eſcape from their priſon than thoſe of other animals, or that the uterus of a woman affords not ſo free a paſſage to the child; for it is by the ſtruggles of the foetus againſt the reſiſtance it meets with at the orifice of the uterus, that the membranes are torn.

RECAPI-

RECAPITULATION.

ALL animals are nouriſhed by vegetables, or by other animals which feed upon vegetables. There is, therefore, in Nature, a matter common to both, which ſerves for the growth and nouriſhment of every thing that lives or vegetates. This matter can have no other mode of effecting growth and nouriſhment, but by aſſimilating itſelf to every part of the animal or vegetable, and by intimately penetrating the texture and *form* of theſe parts, which I have diſtinguiſhed by the appellation of an *internal mould*. When this nutritive matter abounds more than is ſufficient for the growth and expanſion of the animal or vegetable, it is detached from all parts of the body, and depoſited in one or ſeveral reſervoirs, under the form of a fluid. This fluid contains all the particles which are analogous to the different parts of the body, and, of courſe, all that is neceſſary for the reproduction of a being in minature perfectly ſimilar to the firſt. In moſt animals, this ſuperfluity of nutritive matter does not take place till they have nearly acquired their full growth; and hence it is that animals are not capable of generating before this period.

When

When this nutritive and prolific matter, which is univerſally diffuſed, has paſſed through the internal mould of an animal or vegetable, and has found a proper matrix, it produces an animal or vegetable of the ſame ſpecies. But, when it finds not a ſuitable matrix, it produces organized beings different from animals or vegetables, as the moving and vegetating bodies which appear in the ſeminal fluids of animals, and in the infuſions of the buds of plants, &c.

This prolific matter is compoſed of organic particles, which are always active, whoſe motions and actions are fixed or arreſted by the brute parts of matter in general, and particularly by oily and ſaline ſubſtances; but, as ſoon as they are diſengaged from this matter, which is foreign to their nature, they reſume their action, and produce different ſpecies of plants, and other animated beings.

The effects of this prolific matter may be ſeen by the microſcope in the ſeminal fluids of both male and female animals. The ſemen of viviparous females is filtrated through the glandulous bodies which grow upon their teſticles; and theſe glandulous bodies contain a conſiderable quantity of ſeminal fluid in their cavities. Oviparous females, as well as the viviparous, have a ſeminal fluid, which is ſtill more active than that of the viviparous. The ſemen of the female is, in general, ſimilar to that of the male, when both are in a natural ſtate. They decompoſe pofe in the fame manner; they contain fimilar organic particles; and they exhibit the very fame appearances.

All animal and vegetable fubftances contain a great quantity of this organic and prolific matter. To difcover it, we have only to feparate it from the brute matter in which it is entangled; and this operation is effected by infufing animal or vegetable fubftances in water: The falts melt; the oils feparate; and the organic particles become evident by their movements. They abound more in the feminal fluid than in any other parts of animals; or rather, they are there more difengaged from the brute matter. Soon after flefh is infufed, and while it is only flightly diffolved, the organic matter appears under the form of moving bodies, which are nearly as large as thofe in the feminal fluid. But, in proportion to the increafe of the diffolution, the fize of the organic particles is diminifhed, and their motion is augmented; and, when the flefh is entirely decompofed or corrupted, the organic particles are extremely minute, and their motion is inconceivably rapid. It is then that this matter may be poifonous, like that of the viper's tooth, in which Mr Mead perceived an infinite number of fmall pointed bodies, and which he imagined to be falts, though they are nothing but thefe fame organic particles in an extremely active ftate. The pus which proceeds from wounds may acquire fuch a degree

of

of putrefcency, as to become a poifon of the moft active kind; for, whenever this active matter is exalted to a certain point, which may always be diftinguifhed by the rapidity and minutenefs of the moving bodies it contains, it muft become a fpecies of poifon. The fame thing may be remarked with regard to the poifon of vegetables. The fame matter which nourifhes us while in a natural ftate, will deftroy us when it is corrupted, as appears from the gangrenes which affect the limbs of men and other animals, when they are fed with corrupted grain; and from comparing the refidue of the food which adheres to our teeth, with that which proceeds from the teeth of the viper or of a mad dog, which is nothing but the fame matter too much exalted, and in the higheft ftate of putrefaction.

When large quantities of this organic and prolific matter are collected in fome part of an animal, where it is obliged to remain, it there forms living beings, which we have always regarded as real animals. The taenia, the afcarides, all the worms found in the veins, in the liver, in wounds, in pus, and moft of thofe which are formed in putrified flefh, have no other origin. The eels in pafte, in vinegar, and all the pretended microfcopic animals, are only different forms affumed, according to circumftances, by this active matter, which has a perpetual tendency to organization.

In

In infuſions of all animal and vegetable ſubſtances, this prolific matter firſt diſcovers itſelf under the form of vegetation: We ſee it form into filaments, which grow and expand like plants; then their extremities and joints ſwell and burſt to give paſſage to the multitude of moving bodies which have the ſemblance of animals. Nature, it would appear, begins all her operations by a kind of vegetable motion: This motion we perceive in a variety of microſcopic objects, and in the expanſion of the animal embryo; for a foetus, at firſt, poſſeſſes only a ſpecies of vegetable growth or motion.

Sound food furniſhes none of theſe moving particles for a conſiderable time: Freſh meat, grain, fruits, &c. require ſome days infuſion before they exhibit any moving bodies. But the more any matter is corrupted, decompoſed, or exalted, as pus, blighted grain, honey, the ſeminal fluids, &c. theſe moving bodies make their appearance the ſooner. In ſeminal fluids, they are entirely free from other matter; and only a few hours infuſion are neceſſary to diſcover them in pus, corrupted grain, honey, ſtrong drugs, &c.

The exiſtence, therefore, of an organic animated matter, univerſally diffuſed through all animal and vegetable ſubſtances, and which equally ſerves for their nouriſhment, their growth, and their reproduction, is apparent. Nutrition is effected by the intimate penetration of this matter

matter through every part of animal or vegetable bodies; expanſion, or growth, is only a more extenſive ſpecies of nutrition, which proceeds as long as the parts are ductile, and capable of being ſtretched; and reproduction is an effect of the ſame matter, when it ſuperabounds in the body of an animal or vegetable. Every part of organized bodies ſends off to proper reſervoirs the organic particles which are ſuperfluous for its nouriſhment: Theſe particles are perfectly ſimilar to the different parts from which they are detached, becauſe they were deſtined for the nouriſhment of thoſe parts. Hence, when the whole particles ſent off from every part of the body are aſſembled, they muſt neceſſarily form a ſmall body ſimilar to the original, becauſe every particle is ſimilar to the part from which it was detached. It is in this manner that every ſpecies of reproduction, where only one individual is requiſite, as that of trees, plants, polypi, vine-fretters, &c. is effected. This is alſo the firſt method employed by nature for the reproduction of ſuch animals as require the aid of different ſexes; for the ſeminal fluid of each ſex contains all the particles neceſſary for reproduction: But, to complete the operation, ſomething more is requiſite, namely, the mixture of both fluids in a place ſuited to the expanſion and growth of the foetus; and this place is the uterus of the female.

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There are, therefore, no pre-exifting germs, or germs infinitely contained within each other. But there is an organic matter diffufed through all animated nature, which is always active, always tending to form, to affimilate, and to produce beings fimilar to thofe which receive it. The fpecies of animals and of vegetables, therefore, can never be exhaufted: As long as individuals fubfift, the different fpecies will be conftantly new; they are the fame now that they were three thoufand years ago: The whole will perpetually exift by their own powers, unlefs they be annihilated by the will of their Creator.

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NATURAL HISTORY

OF

M A N.

SECT. I.

Of the Nature of Man.

THOUGH man be much interested in obtaining a knowledge of himself, yet I suspect that he is better acquainted with every other object. Endowed by Nature with organs destined solely for our own preservation, we employ them for the reception of external impressions only. Anxious to expand our external existence beyond the limits of our powers, and to multiply the functions of our senses, we seldom employ that internal sense which reduces us to our true dimensions, and distinguishes us from every other being. If, however, we are

 desirous

desirous of knowing ourselves, we must cultivate this sense, by which alone we are enabled to form a dispassionate judgment concerning our nature and condition. But how shall we give to this sense its full extent and activity? How shall we emancipate the soul, in which it resides, from all the illusions of fancy! We have lost the habit of employing this sense; its activity is repressed by the tumult of corporeal sensations, and parched with the heat of our passions; the heart, the imagination, the senses, all conspire to annihilate its exertions. Unchangeable, however, in its nature, and invulnerable by its essence, it continues always the same. Its splendour may be obscured, without losing its force; it may enlighten us less, but it guides us with certainty. Let us collect those rays which it still emits, and the darkness which surrounds us will diminish; and, though the path should not be equally illuminated from one end to the other, we shall at least have a torch to prevent us from wandering.

The first and most difficult step, in arriving at a proper knowledge of ourselves, is to acquire distinct ideas of the two substances of which we are composed. Simply to affirm, that the one is immaterial, unextended, and immortal, and that the other is material, extended, and mortal, is only denying those qualities to the one, which we know the other possesses. What real knowledge can be acquired from this mode of negation?

negation? Such negative expreſſions can communicate no poſitive idea. But, to ſay that we are certain of the exiſtence of the former, and leſs aſſured of that of the latter; that the ſubſtance of the one is ſimple, indiviſible, and has no form, becauſe it manifeſts itſelf only by a ſingle modification, which is that of thought; that the other is leſs a ſubſtance, than a ſubject capable of receiving ſpecies of forms relative to our ſenſes, which are all as uncertain and as variable as the organs themſelves, is advancing one ſtep towards a diſtinct idea of the nature of the two ſubſtances: It is aſcribing to both different and peculiar properties; it aſſigns to them poſitive qualities, and enables us to inſtitute a compariſon between them.

All our knowledge is ultimately derived from compariſon. What is abſolutely incomparable, muſt be incomprehenſible. Of this God is the only example: He cannot be comprehended, becauſe he can be compared with no other being. But every thing which is ſuſceptible of being compared, and of being relatively viewed in different lights, becomes a ſource of human knowledge. The more ſubjects of compariſon which any object affords, the means of forming a proper knowledge concerning it are proportionally increaſed and facilitated.

The exiſtence of the ſoul is ſelf-evident: To be, and to think, are, with regard to us, the ſame thing. This truth is more than intuitive: It is independent of the ſenſes, of the imagination, of the memory, and of all our other relative faculties. But the exiſtence of our bodies, and of external objects, is doubtful to every unprejudiced reaſoner; for that extenſion in length, breadth, and thickneſs, which we call our bodies, and which ſeem to be ſo intimately connected with us, is nothing more than a relation of our ſenſes; and the organs of ſenſation themſelves are only certain affinities with the objects which affect them. Has the internal ſenſe, the mind, any thing common or ſimilar to theſe organs? Have the ſenſations produced by light or ſound any reſemblance to that ſubtile fluid which excites the idea of light, or to the vibration of the air which conveys to us the notion of ſound? Theſe effects reſult ſolely from the neceſſary and intimate relation that ſubſiſts between the eyes and ears and the different matters which act upon them. But, as we have demonſtrated, that there is no reſemblance between ſenſations and the objects which produce them, is not this a ſufficient proof that the nature of the ſoul is different from that of matter?

We may, therefore, conſider it as an eſtabliſhed point, that internal ſenſation is totally different from its cauſe; and we have already ſhown, that, if external objects exiſt, they muſt be very different from the ideas we form of them; becauſe ſenſation has not the moſt diſtant reſemblance to the objects by which it is excited.

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May we not hence conclude, that the causes of our sensations necessarily differ from our notions concerning them? That extension which we perceive by the eye, that impenetrability of which we acquire the idea by touching, and all the other constituent properties of matter, may have no existence; since our internal sensations of extension, impenetrability, &c. are neither extended nor impenetrable, and possess nothing in common with these qualities.

As the mind, during sleep, is affected with sensations which are often different from those excited by the actual presence of the objects, is it not natural to think, that the presence of objects is not necessary to the existence of our sensations, and, consequently, that both mind and body may exist independent of these objects? For, during sleep and after death, the body has the same existence as before, though the mind recognises not this existence, and, with regard to us, the body entirely loses its being. Now I ask, if any object that can exist, and afterwards be no more, which affects us in a manner totally different from what it is, and from what it has been, can be so real as to leave no doubt of its existence?

We may still, however, believe, though we are uncertain, that something exists without us; but we cannot hesitate concerning the real existence of every thing within us. The existence of the soul, therefore, is certain, and that of the body

body feems to be doubtful. The mind has one mode of perception when we fleep, and another when we are awake; after death, fhe will perceive in a manner ftill more different; and the objects of fenfation, or matter in general, may then have no more exiftence with regard to her, than our bodies, with which we have no farther connection.

But, though we admit the exiftence of matter, and that it exifts in the very manner we perceive it; yet, in comparing it with the mind, we fhall find the latter endowed with qualities fo oppofite, that we cannot hefitate concerning the difference of its nature, and the fuperiority of its rank.

It is impoffible to recognife the mind under any other form than that of thinking, which is extremely general, fimple, and uniform. This form is not divifible, extended, impenetrable, nor poffeffes any other quality of matter. The mind, therefore, which is the fubject of this form, muft be indivifible and immaterial. Our bodies, on the contrary, as well as all external objects, have many forms, each of which is compounded, divifible, and deftructible; and the whole are only relative to the different organs by which we perceive them. Our bodies, and matter in general, therefore, poffefs no conftant, real, or univerfal properties, which can enable us to acquire a certainty of their exiftence. A blind man has no idea of the images of bodies prefented preſented to us by means of light. A leper, whoſe ſkin was inſenſible, could have none of thoſe ideas which originate from the ſenſe of feeling. A deaf man knows nothing of ſound. Suppoſing a perſon to be ſucceſſively deprived of theſe three inſtruments of ſenſation, the mind would ſtill exiſt, and manifeſt itſelf by its own internal power of thinking. But, if you abſtract colour, extenſion, ſolidity, and all the other qualities of matter which have a relation to our ſenſes, matter, in this caſe, would be entirely annihilated: The mind, therefore, is indeſtructible; but matter may, and muſt periſh.

The ſame reaſoning applies to the other faculties of the mind, when compared with the moſt eſſential properties of matter. The mind wills and commands; the body obeys as far as it is able: The mind can unite itſelf, in an inſtant, to the moſt diſtant or moſt elevated objects; and nothing can prevent this union, when ſhe commands it to be effected. But the body is incapable of uniting with any object; it is wounded by every thing that makes too cloſe an approach. Every thing reſiſts and becomes an obſtacle to its motions, which are naturally ſlow. Is this will, then, nothing more than a corporeal movement; and is contemplation only a ſimple contact? How could this contact be effected with remote objects, or abſtract ſubjects? Or how could this motion be inſtantaneouſly accompliſhed? Without ſpace and time,

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the idea of motion is inconceivable. The will, therefore, if it be a motion, is not a material motion; and, if the union of the mind with its object be a contact, it muſt be a contact, or rather an intimate penetration, at a diſtance! qualities which are the reverſe of thoſe of matter, and which, of courſe, can belong only to an immaterial being.

But I am apprehenſive of having dwelt too long upon a ſubject, which, by ſome, may be regarded as foreign to the nature of this work. What connection, it may be ſaid, have metaphyſical remarks on the mind with natural hiſtory? If I were conſcious of abilities ſufficient for the diſcuſſion of a topic ſo elevated and extenſive, this reflection, I acknowledge, would not give me any uneaſineſs; and I have abridged my obſervations, ſolely becauſe I deſpaired of being able to comprehend a ſubject ſo immenſe, and ſo important in its nature. Why ſhould the nobleſt part of man be rejected from his hiſtory? Why thus prepoſterouſly debaſe him, by conſidering him merely as an animal, while his nature is ſo different, and ſo ſuperior to that of the brutes, that nothing but the moſt brutal ignorance could ever dream of confounding them?

Man, it is true, reſembles the other animals in the material part of his being; and, in the enumeration of natural exiſtences, we are obliged to rank him in the claſs of animals. But, in nature, there are neither claſſes nor genera; all

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are mere independent individuals. Claſſes and genera are only the arbitrary operations of our own fancy: And, though we place man in one of theſe claſſes, we change not his nature; we derogate not from his dignity; we alter not his real condition; we only aſſign him the firſt rank among beings which reſemble him ſolely in the material part of his exiſtence.

When we compare man with the animal creation, we find in both a material organized body, ſenſes, fleſh and blood, motion, and many other ſtriking reſemblances. But all theſe analogies are external, and authoriſe us not to pronounce, that the nature of man is ſimilar to that of the brute. In order to acquire a diſtinct idea concerning the nature of each, it is neceſſary that we ſhould have as complete a knowledge of the internal qualities of animals as we have of our own. But, as it is impoſſible to know what paſſes within animals, or how to rank or eſtimate their ſenſations, in relation to thoſe of man, we can only judge by comparing the effects which reſult from the natural operations of both.

Let us, therefore, conſider theſe effects; and, while we acknowledge all the particular reſemblances, we ſhall only examine ſome of the moſt general diſtinctions. The moſt ſtupid man, it will be admitted, is able to manage the moſt alert and ſagacious animal: He governs it, and makes it ſubſervient to his purpoſes. This he effects

effects not so much by strength or address, as by the superiority of his nature. He compells the animal to obey him, by his being possessed of reason, which enables him to project and to act in a systematic manner. The strongest and most sagacious animals have not the capacity of commanding the inferior tribes, or of reducing them to a state of servitude. The stronger, indeed, devour the weaker: But this action implies an urgent necessity only, and a voracious appetite, qualities very different from that which produces a train of actions all directed to one common design. If animals be endowed with this faculty, why do not some of them assume the reins of government over others, and force them to furnish their food, to watch over them, and to relieve them when sick or wounded? But, among animals, there is no mark of subordination, nor the least trace of any of them being able to recognize or feel a superiority in his nature above that of other species. We should, therefore, conclude, that all animals are of the same nature, and that the nature of man is not only far superior, but likewise of a very different kind from that of the brute.

Man exhibits, by external signs, what passes within him. He communicates his sentiments by words; and this sign is universal. The savage and the civilized man have the same powers of utterance; both speak naturally, and are equally understood. It is not owing, as some have

have imagined, to a defect in their organs, that animals are denied the faculty of ſpeech. The tongue of a monkey has been diſcovered by anatomiſts to be as perfect as that of a man *. The monkey, therefore, would ſpeak, if it could think. If the train of its thoughts were analogous to that of ours, it would ſpeak the language of men; and ſuppoſing the order and manner of its thinking to be peculiar to the ſpecies, it would ſtill ſpeak a language intelligible to its neighbours. But apes have never been diſcovered converſing together. Inſtead, therefore, of thinking in a manner analogous to man, they ſeem not to have the ſmalleſt order or train in their thoughts. As they expreſs nothing that exhibits combination or arrangement, it follows, either that they do not think, or that the limits of their thinking are extremely narrow.

As ſeveral ſpecies of animals are capable of being taught to pronounce words, and even to repeat ſentences, this is an invincible proof that the want of ſpeech among them is not owing to any defect in their organs. Many other brutes might, perhaps, be taught to articulate words †; but, to make them conceive the ideas which theſe words expreſs, is beyond the power of art. They ſeem to articulate and to repeat merely like an echo or a machine. They are defective,

* See M. Perault, Hiſtory of Animals.

† Leibnitz mentions a dog that had been taught to pronounce ſeveral French and German words.

defective, not in the mechanism of their organs, but in their intellectual powers.

Language implies a train of thinking; and it is for this reason that brute animals are incapable of speech: For, though we should allow them to possess something similar to our first apprehensions, and to our most gross and mechanical sensations, it is certain that they are unable to form that association of ideas in which alone the essence of reflection and of thought consists. They can neither think nor speak, because they can neither join nor separate ideas; and, for the same reason, they neither invent nor bring any thing to perfection. If they were endowed with the power of reflecting, even in the slightest degree, they would be capable of making some progress, and acquire more industry; the present race of beavers would build their houses with more art and solidity than their progenitors; and the bee would daily improve the cell which she inhabits: For, by supposing that this cell has all the perfection of which it is capable, we ascribe to this insect a genius and understanding superior to the human, by which it is enabled, at one glance, to perceive the utmost point of perfection to which its work can be carried. But man never can attain a clear view of this point: Much time, reflection, and practice, are necessary, before the meanest of our arts can be brought to maturity.

Whence

Whence proceeds this uniformity in all the operations of animals? Why does every ſpecies perform the ſame work in the very ſame manner? And why is the execution of different individuals neither better nor worſe than that of every other? Can there be a ſtronger proof that their operations are only the reſults of pure mechanical impulſe? If they poſſeſſed a ſingle ſpark of that inward light which illuminates mankind, we ſhould find variety, at leaſt, if not perfection, in their works; every individual would exhibit ſome difference in his mode of execution. But ſuch differences never appear: They all work upon the ſame plan; their mode of acting runs through the whole ſpecies, and is not peculiar to any individual: If, therefore, we aſcribe to animals a mind or ſoul, we muſt allow but one to every ſpecies, of which each individual has an equal ſhare: This ſoul would, of courſe, be diviſible, and, conſequently, material, and very different from ours.

Why, on the contrary, is ſo much variety exhibited in the operations of men? Why does ſervile imitation coſt us more labour than original deſign? Becauſe our ſouls are proper to us, and independent of any other; and becauſe we poſſeſs nothing common to the ſpecies, but the matter which conſtitutes our bodies, and by which alone we have any reſemblance to the brute creation.

If

If internal ſenſation depended on corporeal organs, ſhould not as great a variety appear in the operations of the ſame ſpecies of animals, as in thoſe of men? Would not thoſe endowed with finer organs build their neſts, and their cells, in a manner more ſolid, elegant, and commodious? If any individual had more genius than another, would it not be rendered conſpicuous by its mode of acting? But nothing of this kind is ever exhibited: The greater or leſſer perfection of corporeal organs, therefore, has no influence upon the nature of internal ſenſation. From this circumſtance, we may ſafely conclude, that animals poſſeſs no ſenſations of this kind; that they neither belong to matter, nor depend, as to their nature, upon the texture of corporeal organs; and of courſe that there is in man a ſubſtance totally diſtinct from matter, which is the ſubject and the cauſe that produce theſe ſenſations.

But theſe proofs of the immateriality of the human mind may be extended ſtill farther. We have often remarked, that Nature proceeds in her operations by imperceptible degrees. This truth, which otherwiſe admits of no exception, is here totally reverſed. Between the faculties of man and thoſe of the moſt minute animal, the diſtance is infinite. This is a clear proof, that the nature of man is different from that of the brute creation; that he himſelf conſtitutes a ſeparate claſs from which there are numberleſs

degrees

degrees of deſcent, before we arrive at the ſtate of the mere animal; for, if man were of the ſame rank with the animals, there would be in nature a certain number of beings leſs perfect than man, and ſuperior to any animal we are acquainted with; and thoſe intermediate beings would deſcend imperceptibly from man to the monkey tribes. But no ſuch beings exiſt. The paſſage is ſudden from a thinking being to a material one, from intellectual faculties to mechanical powers, from order and deſign to blind impulſe, from reflection and choice to ungovernable appetite.

This is a ſtrong indication of the excellence of our nature, and of the immenſe diſtance fixed by the bounty of the Creator between men and animals. Man is a reaſoning being; the animal is totally deprived of that noble faculty: And as there is no intermediate point between a poſitive and a negative, between a rational and an irrational animal, it is evident that man's nature is entirely different from that of the animal; that the latter only reſembles the former in the external or material part; and that, to form a judgment from this material reſemblance alone, is ſhutting our eyes voluntarily againſt that light which enables us to diſtinguiſh truth from falſehood.

Having conſidered the internal nature of man, and demonſtrated the immateriality of his ſoul, we ſhall next examine his external part, and

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give the hiſtory of his body. In the preceding chapters, we have explained his formation and expanſion, and traced him to the very moment of his birth: Let us now run over the different ages of his live; and, after conducting him to that period when he is ſeparated from his body, we ſhall leave it to moulder in the common maſs of matter to which it originally belonged.

SECT. II.

Of Infancy.

NOTHING exhibits ſuch a ſtriking picture of weakneſs, of pain, and of miſery, as the condition of an infant immediately after birth. Incapable of employing its organs or its ſenſes, the infant requires every kind of ſuccour and aſſiſtance: It is more helpleſs than the young of any other animal: Its uncertain life ſeems every moment to vibrate on the borders of death. It can neither move nor ſupport its body: It has hardly force enough to exiſt, and to announce, by groans, the pain which it ſuffers; as if Nature intended to appriſe the little innocent, that it is born to miſery, and that it is to be ranked among human creatures only to partake of their infirmities and of their afflictions.

Let us not diſdain to conſider that ſtate in which our exiſtence commenced: Let us view human nature in the cradle; and, leaving the diſguſt that might ariſe from a detail of the cares which infancy demands, let us inquire by what degrees this delicate and hardly exiſting machine acquires motion, conſiſtency, and ſtrength.

An infant, at birth, paſſes from one element into another. When it eſcapes from the waters which ſurrounded it in the womb of the mother, it is expoſed to the air, and inſtantly feels the impreſſions of that active fluid. The air acts upon the olfactory nerves, and upon the organs of reſpiration. This action produces a ſhock, a kind of ſneezing, which expands the cheſt, and gives the air a free paſſage into the lungs, the veſicles of which it dilates. After the air remains for ſome time, it is heated and rarified to a certain degree, and the ſtimulus or ſpring ariſing from the dilatation of the fibres re-acts upon this rarified fluid, and expells it from the lungs. We will not here attempt to explain the cauſes of the alternate motion of reſpiration, but ſhall confine ourſelves to its effects.

This function is eſſentially neceſſary to the exiſtence of man and of many other animals. If reſpiration ceaſes, the animal muſt periſh; when once commenced, it never ſtops till death; and, after the foetus begins to reſpire, it continues this action without interruption. It is probable, however, that the foramen ovale of the heart does not cloſe immediately after birth, and, conſequently, that part of the blood muſt paſs through that aperture. The whole blood, therefore, enters not, at firſt, into the lungs; and a new-born child may perhaps be deprived of air for a conſiderable time without ſuffocation. This conjecture

jecture ſeems to be confirmed by ſome experiments I lately made upon young dogs. I procured a pregnant bitch, of the large gray-hound kind, and, when juſt about to litter, I fixed her ſo in a bucket full of warm water, that her hinder parts were entirely covered. In this ſituation ſhe brought forth three puppies, which, after being diſengaged from their membranes, were immerſed in a fluid nearly of an equal temperature with that of the amnios. After aſſiſting the mother, and waſhing the puppies in this water, I ſuddenly removed them into a pail of warm milk, without allowing them time to reſpire. I put them into the milk, in preference to water, that they might have an opportunity of taking ſome food, if they found a deſire for nouriſhment. I kept them immerſed in the milk for more than half an hour; and, when taken out of it, all the three were alive. They began to breathe; and they diſcharged a quantity of fluid matter by the mouth. I allowed them to reſpire about half an hour, and again immerſed them in the warm milk, where they remained another half hour. I then took them out: Two of them were ſtill vigorous; but the third ſeemed to languiſh: I therefore ordered it to be carried to the mother, which, beſide the three brought forth in the water, had littered other ſix in the natural manner. The puppy which was born in the water, and had continued one half hour in warm milk, before it was allowed to breathe, and another half hour after it had refpired, feemed to be very little incommoded; for it foon recovered, and was as active and lively as thofe which had received no injury. Of the fix that were brought forth in the air, I threw away four; fo that there remained only two with the mother, befide the one that had been littered in the water. I continued my experiments upon the other two which had been twice immerfed in the milk: After allowing them to breathe about half an hour, I plunged them a third time into the milk, where they remained another half hour. Whether they fwallowed any of the milk, I could not determine; but, when removed, they appeared to be nearly as vigorous as before their immerfion. Having carried them, to the mother, however, one of them died that fame day; but I know not whether its death was owing to fome accident, or to the injury it received from being plunged into the milk, and deprived of air. The other lived as well as the firft; and both grew up, and were equally vigorous as thofe which had not been fubjected to the experiment. I pufhed thefe trials no farther: But I learned enough to convince me, that refpiration is not fo indifpenfibly neceffary to the exiftence of a new-born animal, as to an adult; and that, by employing certain precautions, it is, perhaps, poffible to keep the foramen ovale open, and, by this means, produce excellent divers, or a fpecies of amphibious animals, which

which would be able to live equally in air or in water.

The air, on its firſt entrance into the lungs, generally meets with ſome obſtacle, occaſioned by a fluid ſubſtance collected in the wind-pipe. This obſtacle is greater or leſs, in proportion to the viſcidneſs of the liquor. But the infant, at birth, raiſes its head, which formerly reclined on its breaſt; and, by this operation, the canal of the wind-pipe is lengthened; the air, of courſe, ruſhes in, forces this fluid into the cells of the lungs, which it dilates; and, in this manner, the mucous ſubſtance, which oppoſed the free paſſage of the air, is diffuſed through the whole ſubſtance of the lungs. The perpetual admiſſion of freſh air ſoon dries up this ſuperfluous moiſture; or, if it ſhould ſtill incommode the infant, it excites a cough, and is thrown off by expectoration, which generally runs out of the mouth, becauſe the child has not yet ſtrength enough to ſpit.

We can remember nothing that paſſes at this early period of our exiſtence. It is, therefore, impoſſible to diſcover the feelings produced in the child by the firſt impreſſions of the air. But the cries and groans it utters immediately after birth, are certain indications of the pain occaſioned by the action of the atmoſphere. Till the moment of birth, the infant is accuſtomed to the mild warmth of a tranquil fluid. It is, therefore, conſonant to reaſon, that the action of a fluid, unequal in its temperature, is too violent for the lax and delicate fibres of a new-born infant. It is equally ſenſible of heat as of cold: In every ſituation it utters complaints; and pain appears to be its firſt and only ſenſation.

Moſt animals are blind for ſome days after birth. Infants open their eyes the moment they come into the world; but their eyes are fixed and dull: They have not that luſtre and brilliancy they afterwards acquire; neither have they thoſe motions which accompany diſtinct viſion. But they ſeem to feel the impreſſion of light; for the pupil contracts or dilates, in proportion to the quantity of light. A new-born infant cannot diſtinguiſh objects; becauſe the organs of viſion are ſtill imperfect: The cornea is wrinkled; and perhaps the retina is too ſoft and lax for receiving the impreſſions of external bodies, and for producing the ſenſations peculiar to diſtinct viſion.

The ſame remark may be applied to the other ſenſes. They have not yet acquired that force and conſiſtency which the operation of the ſenſes demand: And, even when they arrive at this ſtate, it is long before the ſenſations of the infant can be juſt and complete. The ſenſes are inſtruments of which we muſt gradually learn the uſe. That of viſion is the moſt noble, and the moſt wonderful; but, at the ſame time, it is the moſt uncertain and eluſory. The ſenſations produced by it, if not rectified every moment

ment by the ſenſe of touching, would uniformly lead us into falſe concluſions. The ſenſe of touching is the criterion of all the other ſenſes: It alone is eſſential to animal exiſtence, and is univerſally diffuſed through every part of the body. But even this ſenſe is imperfect at birth: A new-born infant, indeed, diſcovers ſymptoms of pain by its cries and its groans; but it has no expreſſion that indicates pleaſure. It begins not to ſmile in leſs than 40 days: It is about this time, likewiſe, that it begins to weep; for its former cries were not accompanied with tears. There are no veſtiges of the paſſions in the countenance of a new-born child. The features of the face have not acquired that conſiſtence and elaſticity which are neceſſary for expreſſing the ſentiments of the mind. All the other parts of the infant's body are extremely feeble; and their motions are aukward and ill-directed. It is unable to ſtand erect; its thighs and legs are ſtill bended, from the habit contracted while in the womb of the mother; it has not ſtrength to ſtretch out its arms, or to lay hold of any thing with its hands; and, if abandoned in this condition, it would remain on its back, without being able to turn to one ſide or another.

From theſe remarks, it appears, that the pain felt by infants recently born, and which they expreſs by crying, is only a corporeal ſenſation, ſimilar to that of other animals, who likewiſe cry the moment they are brought forth; and

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that mental ſenſation commences not ſooner than 40 days after birth; for ſmiles and tears are the effects of two internal ſenſations, which both depend upon the action of the mind. The former is an agreeable ſenſation, which originates from the ſight or remembrance of a known and deſirable object: The latter is a diſagreeable agitation, compounded of ſympathy and anxiety concerning our own welfare. Both theſe paſſions preſuppoſe a certain degree of knowledge, and a power of reflecting, and of comparing ideas. Smiles and tears are expreſſions of pleaſure and pain peculiar to the human ſpecies; for the cries, the motions, and the other marks of bodily pains and pleaſures, are common to man and moſt of the other animals.

But we muſt now return to the material organs and affections of the body. The ſize of an infant born at the full time is generally about 21 inches, though ſome exceed, and others fall much below this ſtandard. The breaſt of a child of 21 inches, meaſured by the length of the ſternum, is about three inches, and only two, when the infant exceeds not 14 inches in length. At nine months, a foetus generally weighs from 12 to 14 pounds. The head is large in proportion to the body; but this diſproportion gradually wears off, as the infant increaſes in ſize. The ſkin of a new-born child is very fine, and of a reddiſh colour, its tranſparency allowing a ſlight tint of the blood to ſhine through. It is even alledged, that the redder the ſkin of an infant is at birth, it will afterwards become the fairer and more beautiful.

The form of the body and members of infants, recently after birth, is by no means perfect. The parts are too much rounded; and, even when the child is in high health, they have a ſwollen appearance. A kind of jaundice generally comes on at the end of three days; and, at the ſame time, there is milk in the breaſts of infants, which is ſqueezed out by the fingers. As the growth of the child increaſes, the ſuperfluous juices and ſwelling of the parts gradually diminiſh.

In ſome infants, a palpitation may be ſeen in the fontanella, or open of the head; and, in every child, the beating of the ſinuſes, or arteries of the brain, may be felt at this place. Above this opening, a ſpecies of ſcurf appears, which is often very thick, and muſt be rubbed off with a bruſh, when it becomes dry. This matter ſeems to have ſome analogy to the horns of quadrupeds, which likewiſe derive their origin from an opening in the ſkull, and from the ſubſtance of the brain. We ſhall afterwards ſhow, that the extremities of the nerves become ſolid when expoſed to the air; and that horns, nails, claws, &c. are genuine productions of this nervous ſubſtance.

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The fluid contained in the amnios leaves upon the infant's body a viſcid whitiſh matter, which is ſometimes ſo adheſive, that it requires to be diluted with ſome mild liquid before it can be removed. In this country, we always waſh the infant with warm liquors; but there are whole nations, who inhabit climates much colder than ours, where the infants are plunged into cold water as ſoon as they are born, without receiving the ſmalleſt injury. The Laplanders are even ſaid to leave their new-born infants in the ſnow till their reſpiration is almoſt ſtopped with cold, and then throw them into a warm bath. This rough treatment is continued three times every day for the firſt year: And, after that period, the children are bathed thrice a week in cold water. The inhabitants of the northern regions are firmly perſuaded that cold bathing makes men more healthy and robuſt; and, therefore, they inure their children to this habit from their very birth. We are, indeed, totally ignorant how far our bodies may be rendered capable of ſuffering, of acquiring, or of loſing, by the power of habit. The ſavages in the iſthmus of America, when covered with ſweet, plunge themſelves into cold water with impunity: The women throw their drunk huſbands into the rivers, in order the more ſpeedily to remove the effects of intoxication: The mothers bathe in cold water along with their infants the moment after they are delivered; and

yet

yet much fewer of them die of child-bearing than in other countries, where a practice of this kind would be regarded as extremely dangerous.

Infants, a few minutes after birth, and generally after feeling the heat of a fire, discharge urine, and likewise the meconium or excrement which had been formed in the intestines during their abode in the womb. But this last evacuation does not always happen so soon; and, when it is retarded during the first day, the child is often affected with cholic pains; the discharge must, therefore, be promoted by proper remedies. The meconium is black, and, when entirely purged off, the stools are of a whitish colour. This change generally happens on the second or third day. The odour of the excrement becomes then more offensive than that of the meconium; which is a proof that the bile, and other bitter humours of the body, begin to be mixed with the faeces.

This observation seems to confirm what was formerly advanced concerning the growth and nourishment of the foetus. We then remarked, that the foetus was nourished by absorption, and that it received no food by the mouth. This change in the odour of the excrement is a proof that the stomach and intestines of the foetus have no action, or, at least, that they act not in the same manner, as after the motions communicated to them by respiration; since it is only after this period that digestion, and the mixture of the

the bile and pancreatic juice with the food, takes place in the ſtomach and inteſtines. Thus, though the bile and pancreatic juice are ſecreted in the foetus, theſe liquors remain in their reſervoirs, and paſs not into the inteſtines; becauſe, like the ſtomach, theſe reſervoirs have yet no motion or action ſufficient to make them empty their contents into the receptacles of the food.

Before the child is allowed to ſuck, we allow it time to diſcharge the ſlime and meconium in its ſtomach and bowels. As theſe ſubſtances might ſour the milk, and produce bad effects, we firſt give the child a little wine and ſugar, in order to fortify its ſtomach, and to promote ſuch evacuations as are neceſſary to prepare it for receiving and digeſting its food. Ten or twelve hours, therefore, ought to elapſe, before the child be allowed to ſuck for the firſt time.

The infant has hardly eſcaped from the womb of its mother, and enjoyed the liberty of ſtretching its limbs, when it is again condemned to a more cruel and unnatural bondage. The head of the little innocent is fixed; its leggs are fettered; its arms are bound down to its ſides; and it is laced with bandages ſo ſtrait, that it cannot move a ſingle joint. It is a forunate circumſtance, when the ſwaddings are not drawn ſo tight as to ſtop reſpiration, or when the midwife has the ſenſe to lay the miſerable captive on its ſide, that the natural moiſture may ſpontaneouſly flow from its mouth; for it is denied

denied the liberty of turning its head to facilitate this neceſſary diſcharge. Is it not an inſtance of ſuperior wiſdom in thoſe nations, who ſimply clothe their infants, without tormenting them with ſwaddling-bands? The Siameſe, the Indians, the Japaneſe, the Negroes, the ſavages of Canada, of Virginia, of Braſil, and almoſt all the inhabitants of South America, lay their infants naked into hanging beds of cotton, or put them into cradles lined with fur. Theſe practices are both ſenſible and humane: The reſtraint of ſwaddling-bands muſt be painful. The efforts made by infants to diſentangle themſelves have a more direct tendency to diſtort their members, than any poſitions they could aſſume, if left in the full poſſeſſion of liberty. Swaddling-bands may be compared to the ſtays worn by young girls, which occaſion many more deformities and diſeaſes than they are intended to prevent.

If the efforts for liberty made by infants thus fettered be hurtful, the inactivity to which they are condemned is, perhaps, ſtill more noxious. The want of exerciſe retards the growth of their members, and diminiſhes the ſtrength of their bodies; and, of courſe, thoſe children who are allowed full freedom of motion will be the moſt vigorous and healthy. It was this motive that induced the Peruvians to leave the arms of their infants perfectly looſe, in a wide ſwathing-bag: Afterwards, when their children grew older,

they

they put them up to the middle in a hole dug out of the earth, and lined with linen; their arms, by this contrivance, were at full liberty; and they could move their heads, and bend their bodies, without falling, or hurting themſelves. As ſoon as they were able to ſtep, the breaſt was preſented to them at a little diſtance, to entice them to walk. The children of Negroes are often expoſed to greater difficulties before they can approach the nipple; they cling round one of the mother's haunches with their knees and legs; they adhere ſo faſt, that they ſupport themſelves without the aſſiſtance of the mother; they lay hold of the breaſt with their hands; and they continue to ſuck without inconvenience or danger of falling, though the mother moves about or works at her ordinary labour. Theſe children begin to walk or rather to creep, on their hands and knees, at the end of the ſecond month; and, by exerciſe, they acquire the faculty of running, in this ſituation, with nearly equal quickneſs as they do upon their feet.

Infants, recently after birth, ſleep much; but their ſleep is often interrupted. As they likewiſe require frequent nouriſhment, they ought to have the breaſt once every two hours during the day, and, in the night, as often as they awake. At firſt, they ſleep almoſt continually; and they ſeem never to awake but when ſtimulated by hunger or pain: Their ſleep, therefore, generally terminates by a fit of crying. As, in the cradle,

cradle, they are obliged to lie in the ſame poſition, and are chained down by bandages, this ſituation ſoon becomes painful. They are beſides often wet and chilled by their excrements, the acrimony of which irritates their delicate and ſenſible ſkin. In this condition, the efforts of children are extremely feeble; and their calls for relief are expreſſed by cries and groans. This ſuccour ſhould always be ſpeedily adminiſtered; or rather the inconveniencies they feel ſhould be prevented, by frequently changing part of their clothing. The ſavages are ſo attentive to this article, that, though they cannot change their furs ſo often as we do our linen-cloths; yet they ſupply this defect by employing other ſubſtances, of which they have no occaſion to be ſparing. In North America, they put wood duſt, which they obtain from trees that have been corroded by worms, into the bottom of the cradle, and renew it as often as neceſſary: The children are laid upon this powder, and covered with ſkins. Though this powder may, perhaps, be as ſoft as our down-beds; yet they uſe it not for the purpoſes of delicacy, but becauſe it quickly abſorbs moiſture of every kind. In Virginia, they place the child naked upon a board covered with cotton, and provided with a hole for the paſſage of the excrement. The cold in this country is unfavourable to ſuch a practice; but it is almoſt general in the eaſt of Europe, and particularly in Turkey. This precaution

caution has another advantage; it precludes all kind of care, and prevents the dreadful effects which too commonly result from the common negligence of nurses. Nothing inferior to maternal affection can support that perpetual vigilance and minute attention which the infantine state requires. With what propriety, then, can such exertions be expected from ignorant and mercenary nurses?

Some nurses desert their children for several hours without feeling the smallest anxiety: Others are so callous as not to be affected with their cries. In this situation the unfortunate infants seem to despair; they exert all the force of which they are capable; and their cries only cease when their strength is exhausted. This excessive crying either occasions diseases, or at least throws them into a state of lassitude, which deranges their constitutions, and may have some influence on their tempers. Indolent nurses are guilty of another abuse: Instead of employing proper means for pleasing the child, they rock it violently in the cradle. This agitation confuses the brain, stops the crying, and, if long continued, stuns the child into sleep. But this forced and unnatural sleep is only a palliative; it removes not the original cause of complaint, Long and violent rocking, on the contrary, may disorder the stomach and head, and lay the foundation of future disorders.

Before children are put into the cradle we ought to be certain that they want nothing; and they ſhould never be rocked with ſuch violence as to confound or ſtun them. If they ſleep not ſufficiently, a gentle and equal motion may be employed. Neither ſhould they be often rocked; for, if they be once accuſtomed to this motion, they will not afterwands ſleep without it. Though children, when in health, ſhould ſleep long without the aſſiſtance of art; yet their conſtitution may be injured by too much ſleep. In this caſe, they ſhould be rouſed by gentle motion, by ſoft and agreeable ſounds, and by amuſing them with brilliant objects. This is the period when they receive the firſt impreſſions from the ſenſes, which are, perhaps of more importance during life than is generally imagined.

Infants always direct their eyes to the lighteſt part of a room; and if, from the child's ſituation, one eye only can ſee the moſt luminous part, the other, for want of equal exerciſe, will not acquire equal ſtrength. To prevent this inconvenience, the foot of the cradle, whether the light proceeds from a window or a candle, ſhould be placed oppoſite to the light: In this poſition both eyes receive the light at the ſame time, and conſequently acquire, by exerciſe, an equal degree of ſtrength: If one eye acquires more ſtrength than the other, the child will ſquint; for I have elſewhere proved, that an inequality of ſtrength in the eyes is the cauſe of ſquinting *.

* See Mem. de l'acad. des ſciences, année 1743.

For the firſt two months, the infant ſhould receive no other food than the milk of the mother or nurſe; and, if its conſtitution be delicate, this nouriſhment alone ſhould be continued during the third and fourth month. A child, however robuſt, may be injured, if any other food be adminiſtered before the end of the firſt month. In Holland, in Italy, in Turkey, and through the whole Levant, children are allowed no other food during the firſt year. The ſavages of Canada nurſe their children four or five, and ſometimes ſix or ſeven years. In our country, as moſt nurſes have not a ſufficient quantity of milk to ſatisfy the deſires of their children, in order to ſpare it, they give them, even from the beginning, a compoſition of boiled bread and milk. This nouriſhment appeaſes hunger; but, as the ſtomach and inteſtines are yet too weak to digeſt ſuch a groſs, viſcid ſubſtance, the children are greatly hurt by it, and often die of indigeſtion.

The milk of animals, in caſes of neceſſity, may ſupply that of the mother: But then the child ſhould be obliged to ſuck the animal's teat, that it may receive the milk in an equal and proper degree of heat, and that, by the action of the muſcles in ſucking, the milk may be mixed with ſaliva, which greatly promotes digeſtion. I have known ſeveral peaſants who had no other nurſes than ewes; and yet they were equally vigorous

vigorous as thoſe who had been nurſed by their mothers.

After two or three months, when the child has acquired ſome ſtrength, it may have food ſomewhat more ſolid, as flour baked with milk, a ſpecies of bread which gradually diſpoſes the ſtomach to receive common bread, and ſuch other nouriſhment as it muſt afterwards be accuſtomed to take.

The conſiſtence of liquid food is thus gradually increaſed, that the child's ſtomach may be prepared to receive what is ſtill more ſolid. Infants, during the firſt year, are incapable of maſtication. The rudiments of the teeth are ſtill covered with the gums, which are ſo ſoft, that they can have little effect upon hard ſubſtances. Some nurſes, eſpecially among the common people, firſt chew the food, and then give it to their children. Before reflecting on this practice, we muſt throw aſide every idea of diſguſt, of which children, at this age, have not the leaſt conception. They are equally diſpoſed to receive nouriſhment from the mouth of the nurſe, as from her breaſts. This cuſtom ſeems to have originated from ſome natural inſtinct; for we meet with it in many countries which are exceedingly remote from each other; as in Italy, in Turkey, in moſt parts of Aſia, in America, in the Antilles, in Canada, &c. As it is the only way by which the ſtomachs of children can be ſupplied with a proper quantity of ſaliva, I believe it is very uſeful to them. If the nurſe chews a bit of bread, it is ſoaked in her ſaliva, which renders it fitter for nouriſhment than if it had been diluted in any other liquor. This practice, however, is unneceſſary after children are furniſhed with teeth, which enable them to chew their food, and to mix it with their own ſaliva.

The *inciſores*, or cutting teeth, are eight in number, four in each jaw, and they generally appear about the ſeventh month, though, in ſome caſes, not till the end of the firſt year. Theſe teeth are often premature; for ſome children have them at birth, and foetuſes have been found with teeth completely formed long before the ordinary time of geſtation is finiſhed.

The rudiments of the teeth are lodged in ſockets, and covered with the gums: In the proceſs of their growth, they extend their roots to the bottom of the ſocket, and break through the gums. This proceſs obſerves not the ordinary laws of Nature, which act continually on the human body, without occaſioning any painful ſenſation. Here Nature makes a violent and painful effort, which is often attended with fatal conſequences. Children, when teething, loſe their uſual ſprightlineſs; and become peeviſh and fretful. The gums are at firſt red and ſwelled; and, when the circulation of the blood is nearly ſtopped by the preſſure of the teeth, they turn whitiſh. Children perpetually apply their fingers to the affected part, in order to remove

move the irritation: To procure ſtill farther relief, they are furniſhed with a piece of ivory, coral, or any other hard ſmooth ſubſtance, which they rub againſt the gums. This operation relaxes the parts, affords a momentary ceſſation of pain, renders the gums thinner, and facilitates their rupture. But, notwithſtanding every precaution, the rupture of the gums is always accompanied with pain and danger. When the gums are uncommonly ſtrong and rigid, they reſiſt the preſſure of the teeth for a conſiderable time, and occaſion a violent inflammation, which often proves fatal. The ſimple operation of cutting the gum removes the inflammation, and gives a free paſſage to the teeth.

The canine or dog-teeth, which are four in number, and ſituated next to the cutting-teeth, generally appear in the ninth or tenth month. About the end of the firſt, or during the courſe of the ſecond year, the ſixteen molares or grinders, four on each ſide of the canine-teeth, cut the gums. But theſe periods vary greatly in different children.

The cutting-teeth, the dog-teeth, and the firſt four grinders, are generally ſhed during the fifth, ſixth, or ſeventh year; and are commonly replaced in the ſeventh year, though ſometimes not before the age of puberty. The ſhedding of theſe ſixteen teeth is occaſioned by the expanſion of the rudiments of a ſecond ſet, which are ſituated at the bottom of the ſockets, and, by their growth, puſh out the firſt ſet. But there is no ſecond ſet below the other grinders; and, therefore, they never ſhed but by accident, and their loſs is ſeldom repaired.

There are ſtill other four teeth ſituated at the extremity of each jaw. In ſome perſons, theſe teeth are entirely wanting: They ſeldom appear before the age of puberty, and ſometimes not till a more advanced period. They are diſtinguiſhed by the name of *Wiſdom-teeth*, and either appear ſucceſſively, or two at a time. It is owing to this irregularity in the wiſdom-teeth, that the number of teeth is not uniformly the ſame, which varies from 28 to 32. Women, it has been alledged, have generally fewer teeth than men.

Some authors maintain, that the human teeth, like thoſe of certain animals, would continue to grow during life, if they were not conſtantly worn down by grinding the food. But this notion ſeems to be contradicted by experience; for people who live upon liquid food have not longer teeth than thoſe who eat the hardeſt kinds of aliment. Beſides, thoſe who hold this opinion probably miſtake the tuſks of certain animals for their teeth. The tuſks of the wild boar, and of the elephant, for example, continue to grow during life; but their increaſe, after they arrive at their natural ſize, is extremely doubtful. Tuſks have a greater analogy to horns than to teeth: But this is not a proper

place

place for ſuch diſcuſſions. We ſhall only remark, that, in children, the firſt ſet of teeth are leſs ſolid, and more looſely fixed in their ſockets, than the ſecond.

It has been often aſſerted, that the firſt hair of children is always brown; and that, after it falls off, it is replaced by hair of different colours. I am unable to determine whether this remark be well founded; but the hair of moſt children is fair, and often entirely white. In ſome it is red, and in others black: But in all thoſe who are to have fair or brown complexions, the hair is more or leſs fair in early infancy. Thoſe who are to be fair have generally blue eyes; thoſe who are to be red have yellowiſh eyes; and thoſe who are to be brown have eyes of a dark yellowiſh colour: But theſe diſtinctions are imperfectly marked in children recently after birth; becauſe their eyes are then almoſt always blue.

When infants are allowed to cry long and violently, ruptures are frequently the conſequence of the efforts they make. Theſe are eaſily reduced by the application of bandages. But, if this remedy be too long neglected, the diſeaſe may continue during life. The limits to which I have preſcribed myſelf permit me not to mention all the diſeaſes incident to children. I ſhall only remark on this ſubject, that worms, with which they are often infeſted, are produced from the nature of their food. Milk is a ſpecies

ſpecies of chyle, a purely nutritive ſubſtance, without any mixture: It, of courſe, conſiſts entirely of organic and prolific matter, which, when not properly digeſted by the ſtomach, and applied to the nouriſhment and growth of the body, aſſumes, by its natural activity, other forms, and produces animated beings, or worms, in ſuch profuſion, that the child is often in danger of being deſtroyed by them. The bad effects occaſioned by worms might perhaps be prevented, by allowing children to drink a little wine; becauſe fermented liquors have a tendency to prevent the generation of worms: Fermented liquors likewiſe contain few organic nutritive particles; and it is chiefly by acting on the ſolids, that wine communicates ſtrength to the body; for it contains little nouriſhment. Beſides, moſt children are fond of wine; or, at leaſt, they are eaſily accuſtomed to drink it.

Though the bodies of infants be extremely delicate, they are leſs ſenſible of cold than at any other period of life. Their internal heat, it would appear, is proportionally greater: The quickneſs of the pulſe in children ſeems to fortify this opinion. Small animals, for the ſame reaſon, have unqueſtionably more heat than large ones; for the action of the heart and arteries increaſes in proportion to the comparative ſmallneſs of animals, which takes place in the ſame, as well as in different ſpecies. The pulſe of an infant, or of a little man, is more frequent than that

that of an adult, or of a large man. The pulſe of an ox is ſlower than that of a man; a dog's pulſe is quicker than a man's; and the motion of the heart in very ſmall animals, as that of a ſparrow, is ſo rapid that the ſtrokes can hardly be numbered.

The life of a child, till it be three years of age, is extremely precarious. In the two or three ſucceeding years, however, its life becomes more certain; and, in the ſixth or ſeventh year, a child has a better chance of living than at any other period. By conſulting Simpſon's tables of the degrees of mortality at different ages *, it appears, that, of a certain number of children born at the ſame time, more than a fourth of them died in the firſt year, more than a third in two years, and at leaſt one half in the firſt three years. If this calculation be juſt, when a child is born, we might lay a bet, that it would not live above three years. This exhibits a melancholy view of the human ſpecies; for, though a man who dies at the age of 21 is generally lamented, as being prematurely deprived of life; yet, according to theſe tables, one half of mankind muſt die before the termination of three years; and, conſequently, every man who lives more than three years, inſtead of complaining of his fate, ought to conſider himſelf as peculiarly favoured by his Creator. But this mortality of children is not nearly ſo great in every place

* See Simpſon's tables, publiſhed at London in 1742.

place as in London: M. Dupré de S. Maur has demonſtrated, by a number of experiments made in France, that one half of the children born at the ſame time are not extinct in leſs than ſeven or eight years; and, therefore, we might inſure the life of a new-born child for ſeven or eight years. When a child arrives at five, ſix, or ſeven years, it appears, from the ſame experiments, that its life is more certain than at any other age; for we may then inſure for 42 years more. But, in proportion as it advances above five, ſix, or ſeven years, the number of years it will probably live conſtantly decreaſes. At 12, for inſtance, the chance is equal for 39 years only, at 20 for 33½, at 30 for 28, and ſo on, till the age of 85, when the chance is equal for three years more *.

In the growth of the human body, one thing is exceedingly remarkable. The growth of the foetus increaſes more and more, in equal times, till it eſcapes from the womb. The growth of the child, on the contrary, gradually diminiſhes, in equal times, till the age of puberty, to which it makes a ſudden bound, and ſoon acquires its full ſtature. The foetus, at the end of the firſt month, is an inch long; at the end of the ſecond it is two inches and a quarter; in three months it is three inches and a quarter; in four months it is more than five inches; in five months

* See the tables at the end of this volume.

months, it is ſix and a half, or ſeven inches; in ſix months, it is eight and a half, or nine inches; in ſeven months, it is more than 11 inches; in eight months, it is 14 inches; and in nine months, it is 18 inches. Though theſe meaſures vary in different ſubjects, yet the uniform reſult is, that the foetus, in equal times, continues to have a proportionally greater increaſe. But, if a child at birth be 18 inches long, it will not acquire, for the next 12 months, above ſix or ſeven inches more; that is, at the end of the firſt year, it will be 24 or 25 inches; in two years it will only be 28 or 29 inches; in three years it will be no more than 30, or, at moſt, 32 inches; and afterwards, till the age of puberty, it will not acquire above one and a half, or two inches, every year. Thus the foetus grows more in one month, when near the termination of its abode in the uterus, than the child does in one year, till it arrives at the age of puberty, when Nature ſeems to make a ſudden effort to bring her work to maturity.

For preſerving the health of children, virtuous and wholeſome nurſes are of the utmoſt importance. We have too many melancholy examples of certain diſeaſes being communicated from the nurſe to the child, and from the child to the nurſe. Whole villages have, in this manner, been infected with the venereal virus.

Children, it is probable, would be much more ſtrong and vigorous, if they were nurſed by their

their mothers, whofe milk muft be more agreeable to them than that of any other woman; for the foetus is nourifhed in the womb with a liquor which has a great refemblance to the milk in the breafts. Thus the infant is, in fome meafure, accuftomed to the milk of the mother, even before its birth. But the milk of another woman is not only new to the child, but is often of fo different a nature, that it is difficult to reconcile the child to the ufe of a ftranger's milk. We fometimes fee children, who cannot digeft the milk of certain women, languifh and turn difeafed; and, if they are not fpeedily fupplied with another nurfe, they foon perifh.

Nothing can be more deftructive to children than the practice of crowding numbers of them into the fame hofpital. Moft of them die of infectious difeafes, which they would certainly efcape, if they were brought up in feparate houfes, and particularly at a diftance from great towns. The fame expence would be fufficient to fupport them; and numberlefs citizens, which conftitute the riches of a ftate, would, by this fimple and natural mode of treatment, be faved to the public.

Children begin the difficult tafk of learning to fpeak about the 12th or 15th month. They pronounce the vowel A with moft facility, becaufe it requires only the opening of the mouth, and forcing out the air. E requires the tongue to to be raiſed, at the ſame time that the lips are opened. In pronouncing I, the tongue is ſtill more elevated, and approaches the teeth of the upper jaw. O requires the tongue to be depreſſed, and the lips contracted; and, in the pronunciation of U, the lips muſt be ſtill more contracted, and ſomewhat extended. The firſt conſonants articulated by children are thoſe which require the leaſt motion of the organs. B, M, and P, are moſt eaſily pronounced. B and P require only the lips to be joined, and then opened with celerity; and for M, they muſt be firſt opened, and then quickly ſhut. The articulation of the other conſonants cannot be effected without more complicated movements. The pronunciation of C, D, G, L, N, Q, R, S, and T, depends upon particular motions of the tongue, which are not eaſily deſcribed. F requires a prolongation of ſound beyond any of the other conſonants. Thus, of the vowels, A is moſt eaſily pronounced; and, of the conſonants, B, P, and M. It is for this reaſon that children, in all contries, firſt begin to articulate the words *Baba*, *Papa*, *Mama*. Theſe words are the moſt natural, only becauſe they are moſt eaſily pronounced; and the letters of which they are compoſed muſt exiſt in ever language.

It is worthy of remark, however, that, as the ſounds of ſeveral conſonants are very ſimilar, as thoſe of B and P, of C and S, of K and Q, of

D and T, of F and V, of G and J, of G and K, and of L and R, there may be many languages in which these different consonants are not employed. But, in every language, a B or a P, a C or an S, a K or a Q, a D or a T, an F or a V, a G or a J, an L or an R, are indispensible; and, in the most contracted alphabets, there must be at least six or seven consonants; because the articulation of them is not complicated, and the sounds by which they are uttered are all distinct and different from each other. Children who cannot easily pronounce R, substitute L in place of it, and T in place of D; because the former are more difficult to articulate than the latter: And the softness or harshness of a language depends on the choice of consonants which are more or less difficult to pronounce. But it is needless to enlarge upon this subject.

Some children, at two years of age, articulate distinctly, and repeat whatever is said to them; but most children require a long time. It has been remarked, that those who are long before they learn to speak, never articulate with the same facility as those who acquire that faculty more early. The latter may be taught to read before they are three years of age; and I have known children read amazingly at four. But, after all, it is difficult to determine whether any advantages are to be derived from such premature instruction. We have had so many examples of prodigies

prodigies of learning at four, at eight, at twelve, and at ſixteen years, who turned out to be either fools, or men of very little ability, at twenty-five, that I am inclined to think, that the common mode of education, by which Nature is not prematurely forced, and which is diſcreetly proportioned to the ſtrength and capacity of children, is ſtill the beſt.

SECT.

S E C T. III.

Of Puberty.

PUBERTY commences where childhood ends, and accompanies us through the after periods of life. Before puberty, Nature seems to have had nothing in view but the growth and preservation of her work. The provision she has made for the infant extends no farther than the nourishment and expansion of its members. It lives, or rather enjoys a kind of vegetable existence, which is confined to itself, and which it cannot communicate. But the principles of life soon multiply: We are soon possessed of a stock, sufficient not only for our own being, but for enabling us to bestow existence upon others. This redundancy of life, the source of health and vigour, can no longer be confined, but is strongly impelled to expand and diffuse itself. The age of puberty is accompanied with several external and internal marks. It is the spring of life; the season of pleasure. May we be enabled to write the history of this critical period, without exciting any ideas but what are strictly philosophical!

In

In the hiſtory of man, puberty, circumciſion, caſtration, virginity, impotence, and many other circumſtances, are articles too eſſential to be omitted. We ſhall, therefore, endeavour to deſcribe them with that delicacy of ſtyle, that philoſophical apathy, which annihilate every looſe deſire, and beſtow on words nothing more than their ſimple and primitive ſignification.

Circumciſion is a cuſtom of great antiquity, and is ſtill practiſed over the greateſt part of Aſia. Among the Hebrews, the operation was performed eight days after birth. In Turkey it is delayed to the ſeventh or eighth year, and ſometimes to the eleventh or twelfth. The children in Perſia are circumciſed at the age of five or ſix; the wound is healed with cauſtic or aſtringent powders; and burnt paper is very generally uſed, which according to Chardin is the beſt remedy. This author tells, that the operation, when performed on grown perſons, is attended with conſiderable pain: That they are obliged to be confined to the houſe three or four weeks; and that death is ſometimes the conſequence.

In the Maldivia iſlands, children are circumciſed at the age of ſeven years. To render the ſkin ſoft, the children are bathed in the ſea ſix or ſeven hours before the operation. The Iſraelites made uſe of a ſharp ſtone: The Jews obſerve the ſame mode in moſt of their ſynagogues. But the Mahometans employ a knife or a razor.

An operation ſimilar to circumciſion is neceſſary in certain diſeaſes. It is a common opinion, that the prepuces of the Turks, and of other nations where circumciſion is practiſed, would naturally grow too long, if they were not curtailed in childhood. Boulaye ſays, that he has ſeen, in the deſerts of Arabia and Meſopotamia, on the banks of the Tigris and Euphrates, numbers of Arabian boys whoſe prepuces were ſo long as to render them incapable of generation, without the aid of circumciſion.

The people of the eaſt have likewiſe longer eye-lids than the inhabitants of other nations. The ſkin of the eye-lids reſembles that of the prepuce. But what relation can take place between the growth of thoſe diſtant parts?

Girls as well as boys are circumciſed, upon the borders of the Perſic Gulph and the Red Sea. But theſe people never perform the operation till the girls have paſſed the age of puberty; becauſe there is no redundance before that period. In other climates, the exceſs of growth in the nymphae appears more early; and is ſo general among certain people, as thoſe upon the river Benin, that they circumciſe both girls and boys eight or ten days after birth. The circumciſion of females was an ancient cuſtom, even in Africa. Herodotus mentions it among the uſages of the Æthiopians.

Circumciſion may, therefore be founded on neceſſity; it has, at leaſt, propriety for its object.

ject. But *infibulation* * and castration must have arisen from jealousy alone. These ridiculous and cruel operations have been invented by gloomy and fanatical tyrants, who, actuated by a mean envy, and a desire of monopolizing natural pleasures, enacted and enforced those barbarous and bloody laws, which make privation a virtue, and mutilation meritorious.

Boys are infibulated by drawing the prepuce forward, piercing it, and putting a small cord through the holes, which remains till the cicatrice of the opposite sides be formed: The cord is then removed, and a ring substituted in its place, which is made of sufficient strength to last as long as the person who ordered the operation pleases; and sometimes it remains for life. The eastern monks, who take on the vow of chastity, employ a large ring, which renders a breach of their oath impossible. We shall afterwards mention the method of infibulating females. It is impossible to imagine any thing too ridiculous upon this subject, which has not been practised by some men, either from motives of passion or of superstition.

During infancy, there is sometimes but one testicle in the scrotum, and sometimes none. We must not, however, conclude that children in this situation are totally destitute of these parts. It often happens, that the testicles remain in the

 abdomen,

* This word signifies the operation of tying or sewing parts together.

abdomen, or are entangled in the rings of the muſcles. But time generally removes theſe obſtacles; and the teſtes deſcend into their proper receptacle at the age of eight or ten, and ſome times not till the ſeaſon of puberty. Parents, therefore, have no reaſon to be anxious about ſuch of their children as ſeemingly have no teſtes, or but one. The teſticles of adults are ſeldom concealed; becauſe nature, at the age of puberty, makes ſtrong efforts to bring them to light. The ſame effect is ſometimes produced by diſeaſe, or violent motion, ſuch as a leap, a fall, &c. Even when the teſticles never make their appearance, the purpoſes of generation are not fruſtrated. Men of this kind are often endowed with uncommon vigour.

There are men who have but one teſticle. This defect, however, is inoffenſive; for it is always uncommonly large. Some men have three, and are, on that account, ſaid to poſſeſs more vigour and bodily ſtrength. We learn, from the animal creation, how greatly theſe parts contribute to ſtrength and courage. How different is an ox from a bull, a wedder from a ram, and a capon from a cock?

The practice of caſtration among mankind is very extenſive, and of great antiquity. It was the puniſhment of adultery among the Ægyptians. In the Roman dominions, the number of eunuchs was conſiderable: At this day, theſe mutilated males are employed through all Aſia and

and part of Africa, as guards upon the chaſtity of the ladies. In Italy, this infamous, this cruel operation, has nothing for its object but the improvement of the voice. The Hottentots cut off one teſticle, becauſe they imagine that this operation renders them more ſwift in the chaſe. In other countries, the poor people mutilate their children, to make them incapable of procreation, and to prevent them from feeling thoſe excruciating pangs which they themſelves ſuffer, when they want bread to ſupport their offspring.

The ſpecies of caſtration vary according to the object in view. When the improvement of the voice is intended, the two teſticles are only cut out. But men, whoſe minds are inflamed with jealouſy, would not believe their females to be ſafe in the cuſtody of ſuch eunuchs: They employ none but ſuch as have been deprived of the whole external parts of generation.

But amputation is not the only means of accompliſhing this end. Formerly, the growth of the teſticles was prevented, and their ſtructure deſtroyed, without any inciſion: They bathed the infants in warm water and decoctions of plants, and then preſſed and rubbed the teſticles for a long time, in order to deſtroy their texture. Others compreſſed them with an inſtrument: Some pretend, that this ſpecies of caſtration does not endanger life.

The amputation of the teſticles is not very dangerous: It may be done at any age; the time of infancy, however, is always preferable. But the amputation of the whole external parts of generation is often fatal, especially if performed after the age of fifteen years. Even in the most favourable time, which is from seven to ten years of age, there is always great danger. The difficulty of preserving eunuchs of this kind renders them exceedingly precious. Tavernier informs us, that, in Turkey and Persia, they bring five or six times the price of the other kind. Chardin observes, that the total amputation is accompanied with the most exquisite pain; that it is performed pretty safely upon young children; and is exceedingly dangerous after the age of fifteen; that hardly a fourth part escape with life; and that the wound is never cured in less than six weeks. On the other hand, Pietro della Valle asserts, that those who suffer this punishment in Persia for rapes, and other crimes of that nature, heal easily, though advanced in years; and that they apply nothing but ashes to the wound. I know not whether those who underwent the same punishment in Egypt, as Diodorus Siculus relates, escaped with equal ease. According to Thevenot, vast numbers of negroes, who are forced by the Turks to submit to this operation, perish, even when it is performed on children of eight or ten years of age.

Beside negro eunuchs, there are others at Constantinople, throughout all Turkey, Persia, &c. who, for the most part, are brought from the

the kingdom of Golconda, the peninſula on this ſide the Ganges, the kingdoms of Aſſan, Aracan, Pegu, and Malabar, where their colour is gray; and from the Gulf of Bengal, where they are of an olive colour: There are ſome white eunuchs from Georgia and Circaſſia; but their number is ſmall. Tavernier ſays, that, when he was in the kingdom of Golconda, in the year 1657, 22000 males were caſtrated. The black eunuchs come from Africa, and eſpecially from Æthiopia. In proportion to the ugglineſs and horror of their appearance, they are the more eſteemed, and bring a higher price. A very flat noſe, a frightful aſpect, large thick lips, and, above all, black teeth placed at a great diſtance from each other, are admired qualities in a eunuch. Theſe people have commonly fine white teeth: But ſuch teeth would be a capital defect in a eunuch, who ought to be a hideous monſter.

Eunuchs, who are only deprived of their teſticles, have a lively ſenſe of titulation in what remains: They have even the external ſign more frequently than other men. The part which remains, however, is generally ſmall; for it continues nearly in the ſame ſtate in which it was before the operation. A eunuch caſtrated at ſeven years of age, when arrived at 20, is no better, with regard to this matter, than a child of ſeven. Thoſe, on the other hand, who have not undergone the operation till the age of puberty,

berty, or later, have parts nearly equal to thofe of found men.

Peculiar relations fubfift between the throat and the parts of generation, though we are totally ignorant of their caufes. Eunuchs have no beard; their voice, though ftrong and piercing, can never reach a low or deep tone. Secret difeafes often appear in the throat. The remarkable fympathy which fome parts of the body have with others, though at a diftance, and of a different nature, is a fubject too much neglected: We are apt to defpife effects, when we cannot eafily difcover their caufes. Hence it is, that we never think of examining thefe relations or fympathies, although they are the proper fpring of the animal conftitution. In females, there is a remarkable fympathy between the uterus, breafts, and head. How many curious and ufeful facts of this nature might be difcovered, if phyficians paid more attention to this interefting fubject? It would produce more enlightened views, and a more extenfive utility, than can ever be expected from a mere regifter of anatomical names. It is impoffible to difcover the principles of animal motion: The fprings which give life to organization are not to be found in the mufcles, veins, arteries, and nerves, defcribed with fuch minutenefs by anatomifts. Organized bodies are poffeffed of internal powers, upon which the grofs laws of mechanifm have no influence. Inftead of attempting to difcover

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theſe powers, by attending to their effects, they have been treated as ideal exiſtences; they have ceaſed to be the objects of philoſophical reſearch. They have at laſt reaſſumed their native importance in the laws of gravitation, in elective attractions, in the phaenomena of electricity, &c. But, notwithſtanding the evidence and univerſality of their exiſtence, as their action is internal, as they are ſolely objects of reaſon, and have little connection with the ſenſes, they are in danger of eſcaping our obſervation, and we admit them with difficulty; for judgment is generally occupied and directed by external objects. We never imagine that the internal conſtitution of animated beings ought to be a principal object of inquiry. We conceive that the human genius is limited to external objects; and, therefore, we overlook every thing that might lead to a more refined and ſpiritual philoſophy.

The ancients, leſs limited in genius, and poſſeſſed of a more comprehenſive philoſophy, were not aſtoniſhed to meet with facts which were inexplicable: They viewed Nature through a more tranſparent medium. A peculiar correſpondence or ſympathy, was to them only a phaenomenon; but, to us, becauſe not reducible to ſome fanciful laws of motion, it is a paradox. They knew that Nature produced her principal effects by laws concealed from human eyes: They knew, that, to trace her various laws and

modes

modes of operation, exceeded the powers of our circumſcribed faculties. A certain number of uniform and related effects, therefore, was to to them ſufficient to conſtitute a cauſe, or law of nature. Whether, according to the ancients, this ſympathy ſhall be called a peculiar correſpondence between different parts of the body, or, according to the moderns, it ſhall be conſidered as an unknown relation in the action of nerves, its exiſtence in the animal oeconomy is univerſal; its effects, therefore, are of the utmoſt importance to the theory of medicine, and cannot be too diligently ſcrutinized. But this is not the place for a full inveſtigation of ſuch an important ſubject. I ſhall only obſerve, that the relation between the voice and the generative organs takes place not only in eunuchs, but in other men: It is even diſcoverable in females. In men, the voice changes at the age of puberty; and in women, who have a ſtrong rough voice, the paſſion of love is ſuſpected to be violent.

The firſt ſymptom of puberty is a ſenſe of fullneſs and ſtiffneſs in the groins, which is moſt perceptible when walking, or when the body is bent forward. This ſtiffneſs is often accompanied with pretty ſmart pain in the different joints of the limbs: It is likewiſe accompanied with a new and peculiar ſenſation in thoſe parts which diſtinguiſh the ſexes. Small whitiſh tubercles alſo begin to appear in theſe parts, which are the germs of their natural veil. The voice, for a conſiderable time, is rough and unequal; after which

which it becomes more full, articulate, and ſtrong. This change is very conſpicuous in boys; but it is leſs diſtinguiſhable in girls, becauſe their voices are naturally more ſharp.

Theſe marks of puberty are common to both ſexes: But each ſex has marks peculiar to itſelf; as the eruption of the menſes, and the expanſion of the breaſts in women; the beard and faculty of procreating in men. Theſe marks, indeed, are not always uniform. The beard, for example, does not always appear preciſely at the age of puberty: There are even whole nations who have hardly any beard. On the contrary, there is no country where the age of puberty in women is not diſtinguiſhed by the enlargement of the breaſts.

Among every race of mankind, the females arrive at puberty ſooner than the males. But the age of puberty is very different in different countries. It ſeems to depend upon the temperature of the climate and the quality of the food. The children of citizens and of opulent parents, who are generally fed with rich and nouriſhing victuals, arrive ſooner at this ſtate. But children brought up in the country, or whoſe parents are poor, require two or three years longer; becauſe their food is not only bad, but given too ſparingly. In the ſouthern parts of Europe, and in cities, girls arrive at puberty about the age of 12, and boys about 14. But, in northern climates, and in the country, girls hardly come

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to maturity till they are 14, and boys not before 16.

It may be aſked, Why are the females, in all climates, capable of procreating ſooner than the males? The anſwer is eaſy: The bodies of men are larger and ſtronger; their bones are harder, and their muſcles more compact; a longer time is therefore neceſſary for their growth. Beſides, as the growth of the body muſt be nearly complete before a ſuperfluous quantity of organic juices can be accumulated in the parts deſtined for generation, women, of courſe, muſt arrive at maturity ſooner than men.

In the warmeſt climates of Aſia, Africa, and America, the age of puberty commences in girls at ten, and ſometimes at nine. The periodic diſcharge, though leſs abundant in warm climates, appears much ſooner. The interval is nearly the ſame in all nations. With regard to time, a greater diverſity takes place between individuals than between nations. In the ſame climate and nation, ſome females ſuffer this evacuation every 15 days; others have an interval of ſix weeks: But a month, or a few days more or leſs, is the moſt uſual period.

The quantity evacuated ſeems to depend upon the quantity of nouriſhment and of inſenſible perſpiration. The diſcharge is greateſt in females who eat largely and take little exerciſe: It is leaſt in warm countries, where the perſpiration is more copious. The quantity of this

diſcharge

diſcharge has been variouſly eſtimated. It is, indeed, difficult to make an accurate meaſure. In different ſubjects, and different circumſtances, it varies from one or two ounces to a pound, and even more. It generally continues to flow three, four, or five days; but ſometimes it remains for ſix, ſeven, and even eight days. The cauſe of this diſcharge is generally aſcribed to a ſuperfluity of bloody and nutritious juices. The ſymptoms which precede it are certain indications of a plethora, as heat, tenſion, ſwelling, and the pains felt not only in the parts themſelves, and their environs, but in the mammae, which alſo ſwell, and diſcover a ſuperabundance of blood by the colour of the areolae becoming then more deep: The eyes likewiſe are heavy, and the ſkin below the orbits takes on a faint blue or a violet colour: The cheeks glow; the head is heavy and affected with pain; and, in a word, the whole body is oppreſſed with a ſurcharge of blood.

The growth of the body, in length, generally terminates at the age of puberty. Before this period, young people commonly ſhoot up ſeveral inches in a very ſhort time. But the quickneſs of growth is moſt remarkable in the parts of generation of both ſexes. In males, this growth is only an augmentation in ſize: But, in females, it often produces a ſhrinking of ſome of the parts, which has received different appellations

from

from thoſe who have treated of the ſigns of virginity.

Men, jealous of pre-eminence of every kind, have always diſcovered a remarkable attachment to prior and excluſive poſſeſſions. This ſpecies of folly has beſtowed a phyſical exiſtence upon female virginity. Virginity, which is a moral being, a virtue exiſting ſolely in purity of heart, has been metamorphoſed into a phyſical object, in which moſt men think themſelves deeply intereſted. This notion, accordingly, has given riſe to many abſurd opinions, cuſtoms, ceremonies, and ſuperſtitions; it has even given authority to pains and puniſhments, to the moſt illicit abuſes, and to practices which ſhock humanity. Young women have been obliged to ſubmit to the examinations of ignorant matrons, and to expoſe the ſecrets of nature to the eyes of prejudiced phyſicians. They did not reflect, that every indecency of this kind is a violent attack againſt chaſtity; that every ſituation which produces an internal bluſh, is a real proſtitution.

I have little hope of being able to eradicate the ridiculous prejudices which have been formed on this ſubject. Mankind always believe what they wiſh to be true, however vain and unreaſonable the foundations of their faith. But, as it is the province of hiſtory to relate not only the ſucceſſion of events, and the circumſtances of facts, but likewiſe the origin of popular opinions and errors, I think it a neceſſary article in the

the hiſtory of man, to examine this favourite idol which he adores, to conſider the reaſonableneſs of his worſhip, and to inquire whether Virginity be a real or a fabulous divinity.

Fallopius, Veſalius, Diemerbroek, Riolan, Bartholin, Heiſter, Ruyſch, and ſome other anatomiſts, maintain, that the membrane of the hymen has a real exiſtence, and that it ought to be reckoned among the parts of generation peculiar to females. They aſſert, that it is a fleſhy membrane, very thin in infants, but thicker in adults; that it is ſituated under the orifice of the urethra, and nearly ſhuts up the entrance of the vagina; that it is perforated by a round or oval hole, ſo ſmall as hardly to admit a pea during infancy, or a large bean at the age of puberty. The hymen, according to Winſlow, is a membranous fold, ſometimes circular, and ſometimes ſemilunar, with an aperture of a ſmaller or greater ſize in different ſubjects, &c. On the other hand, Ambroſe Paré, Dulaurent, De Graaff, Pineus, Dionis, Mauriceau, Palfyn, and other anatomiſts of equal authority with thoſe formerly mentioned, inſiſt, that the membrane of the hymen is a mere chimera; that it is not natural to young girls; and expreſs their aſtoniſhment that any man ſhould talk of it as a thing which has a real and uniform exiſtence. They produce a multitude of experiments and obſervations made upon ſubjects of different ages, in which they could never diſcover any appearance

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of this membrane. They acknowledge, that they have ſometimes, but very ſeldom, ſeen thoſe fleſhy protuberances called carunculae myrtiformes connected by a membrane; but they maintain that this membrane was preternatural. Anatomiſts are not leſs divided with regard to the number and qualities of theſe carunculae. Are they only rugoſities of the vagina? Are they diſtinct and ſeparate parts? Are they the remains of the hymen? Is their number uniform? Does only one, or many, accompany the ſtate of virginity? All theſe queſtions have been ſtated, and each has received a different ſolution.

This oppoſition of ſentiment, in a matter which depends on inſpection, is an inconteſtible proof, that mankind have often an ardent deſire to diſcover things in Nature which exiſt in their own imaginations only. Many anatomiſts of reputation have never been able to diſcover either the hymen or carunculae, even before the age of puberty. Thoſe who ſupport the contrary opinion, at the ſame time acknowledge, that theſe parts are not always the ſame; that their form, ſize, and texture, vary in different ſubjects; that, in place of the hymen, ſometimes there is but one caruncula, at other times there are two or more united by a membrane; that the ſhape of the aperture is not uniform, &c. What is the conſequence? We muſt conclude, that the cauſes of this mark of virginity are equivocal and inconſtant; and that, even when

when they have existence, they produce only an effect of a transient and variable nature. Anatomy determines nothing with regard to the existence of the hymen and carunculae; it allows us to reject these symptoms of virginity, because they are not only uncertain, but imaginary.

The effusion of blood, though a more common symptom, is not less equivocal. It has, in all ages been regarded as an infallible proof of virginity. But it amounts to nothing, in all those cases where the entrance of the vagina is naturally relaxed or dilated. Besides, the effusion of blood is not peculiar to virgins. Women who have no pretentions to virginity frequently experience this discharge. Some discharge copiously and often; others a small quantity, and only once; and some have no such effusion. This phaenomenon depends upon age, health, structure of parts, and a number of circumstances. Of these we shall enumerate only a few, and endeavour, at the same time, to investigate the true causes of the various physical marks which have been held forth as infallable characteristics of female virginity.

At the time of puberty, the parts of both sexes undergo a considerable change: Those of the male have then a growth so quick, that they arrive in a year or two at full maturity. Those of women increase likewise at this period. The nymphae, in particular, which, though formerly almost imperceptible, now become full and conſpicuous. The menſtrual diſcharge appears at the ſame period. By an unuſual accumulation of blood, all the parts ſwell, and approach towards each other. The orifice of the vagina contracts, though the dimenſions of the vagina itſelf be enlarged. The appearances produced by this contraction are different in different ſubjects; for we are informed by anatomiſts, that there are ſometimes four and ſometimes only three, or two, *carunculae*; and that a circular or ſemilunar ring, or rather a ſeries of folds, is a common phaenomenon. But anatomiſts have neglected to tell us, that, whatever form this contraction aſſumes, it never appears before the age of puberty. In young girls whom I have had occaſion to diſſect, nothing of this kind could be diſcerned; and, having collected many facts concerning this ſubject I can with confidence aſſert, that when young women, before puberty, have commerce with men, no effuſion of blood ever happens, unleſs the parts be greatly diſproportioned, or ſome violence is committed. On the other hand, at the time of puberty, eſpecially when the females are regular, and in good health, theſe effuſions are common, and produced by the ſlighteſt cauſes. But thoſe who are meagre, and ſubject to the fluor albus, generally want this mark of virginity. The frequent repetition of this flux of blood, and even at conſiderable intervals of time, is an evident demonſtration that it is only a deceitful appear-

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ance. It is a certain fact, that young women, who at first had a copious effusion, have repeated this pretended symptom of virginity after a few months abstinence. This phaenomenon may, by proper management, be frequently exhibited, especially before the body has acquired its full growth. It is equally certain, that young women, who have not been faithful to the marriage-bed, have, notwithstanding, by the simple expedient of abstinence, given fresh proofs of innocence to their deluded husbands. Some women, in the course of two or three years, have exhibited this fictitious mark of purity five times. But this symptom is limited to a certain time; for it seldom appears after the age of eighteen years. When the growth of the body is compleated, its parts become fixed and unalterable, and cannot assume differences but by the employment of such artifices as it would be both unnecessary and improper to relate. Besides, many women, particularly those who are irregular in their menses, and subject to the fluor albus, never have any fresh marks of virginity.

Nothing, therefore, can be more chimerical than the prejudices of men with regard to virginity, and nothing can be more fallacious than its pretended signs. A young woman may have commerce with a man before the age of puberty, and yet exhibit no marks of virginity. But the same woman, after she arrives at puberty, may have very copious effusions of blood.

Others, who are actual virgins, difcover no fuch appearances. Men, therefore, fhould be perfectly eafy as to this matter, and not indulge, as is too often the cafe, unjuft and ridiculous fufpicions.

If we wifh to obtain an evident and infallible mark of virginity, we muft fearch for it among thofe barbarous people, who are incapable of inftilling by education the fentiments of virtue and honour into their children, but fecure the chaftity of their daughters by an expedient which could only be fuggefted by the rudenefs of their manners. In Æthiopia, and other parts of Africa, in Pegu, Arabia Petrea, and other nations of Afia, the inhabitants, immediately after the birth of females, few up thofe parts which Nature has feparated, leaving only a fpace fufficient for the natural evacuations. As the child grows, the parts gradually adhere, and, when the time of marriage arrives, they are again difunited by incifion. Inftead of thread, the fibres of the afbeftos are faid to be employed, which is a fubftance not liable to fudden corruption. Some tribes content themfelves with putting a ring through the parts. To this operation wives as well as girls are fubjected, with this difference, that the ring allotted to the latter cannot be removed, but, in that allotted to the former, there is a lock, of which the hufband alone poffeffes the key. But why fhould we mention barbarous nations, when we have fimilar examples at

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no great diſtance? That abſurd delicacy of a neighbouring nation, with regard to the chaſtity of their wives, is the offspring of a brutal and criminal jealouſy.

How oppoſite are the taſtes, the diſpoſitions, the opinions, and the manners of different nations? After what has been related concerning the high eſtimation of virginity among the bulk of mankind, and the numberleſs precautions and ignominious methods employed to ſecure it, is it poſſible to believe that there are other people who deſpiſe virginity, and conſider the trouble of removing it to be a mean and ſervile office?

Superſtition has induced the inhabitants of certain countries to reſign the firſt fruits of virginity to their idolatrous prieſts, and ſometimes to the idols themſelves. This privilege is enjoyed by the prieſts of Cochin and of Calicut; and, in Goa, the virgins are proſtituted by their parents, either voluntarily or from choice, to an idol of iron. Groſs ſuperſtition induces theſe people to commit ſuch abominable outrages from religious motives. But views more ſervile and intereſted have induced men of other countries to devote their daughters to their chiefs. The inhabitants of the Canary iſles, and of the kingdom of Congo, proſtitute, in this manner, their daughters, without any injury to their reputation. Nearly the ſame cuſtom takes place in Turkey, Perſia, and ſeveral other countries both of Aſia and Africa. Their moſt eminent nobles think themſelves highly honoured to receive from their ſovereign women with whom he himſelf is already diſguſted.

In the kingdom of Arracan, and in the Philippine iſlands, a man would eſteem it to be diſgraceful to marry a young woman who had not been previouſly deflowered; and nothing but the force of money can prevail on any perſon to precede the huſband. In the province of Thibet, mothers anxiouſly ſearch for ſtrangers, and earneſtly ſolicit them to put their daughters in a proper ſtate for obtaining huſbands. The Laplanders likewiſe prefer girls who have had commerce with ſtrangers. They fancy them to poſſeſs uncommon merit, becauſe they have been able to pleaſe men who are better judges of beauty and female accompliſhments than themſelves. In Madagaſcar, and ſeveral other countries, the moſt diſſolute and debauched women are ſooneſt married. Many other examples might be given of this ſtrange taſte, which nothing but the groſſeſt and moſt depraved manners could produce.

After puberty, marriage is the natural ſtate of man. A man ought to have but one wife, and a woman but one huſband. This is the law of nature; for the number of females is nearly equal to that of males. Such laws as have been enacted in oppoſition to this natural principle, have originated ſolely from tyranny and ignorance. Reaſon, humanity, and juſtice revolt

revolt againſt thoſe odious ſeraglios, in which the liberty and the affections of many women are ſacrificed to the brutal paſſion of a ſingle man. Does this unnatural pre-eminence render theſe tyrants of the human race more happy? No! Surrounded with eunuchs, and with women uſeleſs to themſelves and to other men, they are tormented with the conſtant appearance of that accumulated load of miſery they have created.

Marriage, therefore, as it is eſtabliſhed among us, and other nations who are directed by the lights of reaſon and revelation, is a ſtate moſt conſonant to the nature of man, and in which it is his duty to employ thoſe new faculties he acquires from puberty. By obſtinately perſiſting in celibacy, theſe powers become troubleſome, and ſometimes fatal. In either ſex, too long continency may give riſe to diſeaſes, or create irritations ſo violent, that neither reaſon nor religion may be able to counteract the impetuoſity of thoſe paſſions they excite: And thus man may be reduced to a level with the brutes, which, under the influence of ſuch ſenſations, become perfectly furious and ungovernable.

In women, the furor uterinus is the moſt violent effect of this irritation. This diſeaſe is a ſpecies of madneſs, which deranges their ideas, and deprives them of all ſenſe of ſhame. Both the nature and the ſeat of this melancholy diſ-

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temper are indicated by the moſt laſcivious expreſſions, and the moſt indelicate actions. I have ſeen, with aſtoniſhment, a girl at the age of twelve years, who had a brown, but lively and florid complexion, and, though low in ſtature, was ſtrong and plump, commit the moſt indecent actions upon the very appearance of a man, from which ſhe could not be deterred, either by the preſence or chaſtiſement of her mother. She did not, however, loſe her reaſon; and the paroxyſms of the diſeaſe ceaſed, the moment ſhe was left with her own ſex. Ariſtotle alledges, that, at this age, the irritation is ſtrongeſt, and that girls ought then to be carefully watched. The remark may be applicable to the climate in which he lived; but, in colder countries, the ardor of the female conſtitution does not appear ſo early.

When the furor uterinus increaſes to a certain degree, marriage will not remove it; and there have been inſtances of its proving fatal. Happily the force of nature is ſeldom the only cauſe of a paſſion ſo deteſtible, even when there is a prediſpoſition to it in the habit of body. Before it arrives at this extremity, the imagination muſt be inflamed by licentious converſation, by obſcene repreſentations, or other cauſes. Among women, the oppoſite temperament is infinitely more common; for, with regard to this paſſion, moſt of them are either cool or indifferent. There are alſo many men to whom chaſtity is

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an eaſy virtue. I have known ſome men who, at the age of twenty-five or thirty, enjoyed good health, without having ever felt this paſſion ſo ſtrong as to render any gratification neceſſary.

Continency, however, is leſs to be dreaded than exceſs. The number of immoderate men is too great to require particular examples. By exceſs, ſome have loſt their memory; ſome have been deprived of ſight; ſome have become bald; and many have periſhed by pure debility. Young perſons can never be ſufficiently warned of the irreparable injury to their health, which the indulgence of the venereal appetite never fails to produce. How many ceaſe to be men, or, at leaſt, ceaſe to enjoy the powers of manhood, before the age of thirty? and how many, at fifteen or eighteen, receive the ſeeds of a diſeaſe, diſgraceful in itſelf, and which it is often impoſſible to eradicate?

It has already been remarked, that, at the age of puberty, the growth uſually ſtops. It frequently happens, however, that, even after puberty, a tedious illneſs makes the body increaſe in length more than it would have done in a ſtate of perfect health. This extraordinary increaſe is probably occaſioned by the inactivity of the external organs of generation during the courſe of the diſeaſe. The organic particles do not reach theſe parts, becauſe they are not determined thither by irritation; and this defect of irritation is owing to a laſſitude and imbecility

lity of the parts, which prevent the ſecretion of the ſeminal fluid. Theſe organic particles, therefore, remain in the maſs of blood, and neceſſarily extend the extremities of the bones, nearly in the ſame manner as happens to eunuchs. Thus young people, after recovering from a long ſickneſs, are often taller, but worſe ſhaped, than formerly. Some, for inſtance, become hunch-backed, and others crook-legged; becauſe the ſtill ductile extremities of the bones have been unneceſſarily extended by a ſuperfluity of organic particles, which, in a ſtate of health, would have been exhauſted in the formation of ſeminal fluid.

The production of children is the chief intention of marriage. But this intention is ſometimes fruſtrated. Of the different cauſes of ſterility, ſome are common to both ſexes. But, as theſe cauſes are more apparent in men than in women, they are, therefore, more commonly aſcribed to the former. In both ſexes, ſterility is occaſioned either by a defect in the original conformation, or by accidental injuries done to the organs themſelves. In men, the moſt pernicious defects of conformation are thoſe which affect the teſticles, or the muſcles called *erectores penis*. A wrong direction of the urethra, which is ſometimes not only oblique, but improperly perforated, is another obſtable to generation. The adheſion of the prepuce to the fraenum is another obſtacle; but it is not inſurmountable.

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In women, the conformation of the uterus may likewiſe occaſion ſterility. If the orifice of the uterus be always open, or always ſhut, conception will be equally prevented. But the moſt frequent cauſe of barrenneſs, both in men and women, ariſes from ſome depravity in their ſeminal fluids. I formerly quoted a remark of Valiſnieri, that a corruption of the fluid in the teſticles of women rendered them entirely barren. It is the ſame with men. If the ſecretion by which ſemen is formed be vitiated, the fluid is unfit for impregnation. Theſe cauſes of ſterility are not diſcoverable by any external appearances.

In caſes of ſterility, different means have been employed to diſcover whether the defect proceeded from the man or the woman. Inſpection is the firſt reſource; and, if the barrenneſs be occaſioned by a fault in the external conformation, it is ſufficient. But, if the defect lie in the internal organs, it is hardly poſſible either to diſcover or remove it. Some men, though they appear to be perfectly formed, want the genuine ſign of a proper conformation. Others have this ſign ſo imperfectly, or ſo ſeldom, that it is only a very equivocal mark of virility.

Every body knows that the action of this part is not under the command of the mind. It is the moſt animal part of the human body; for it acts by a kind of inſtinct, the cauſes of which are unknown. How many young perſons, e-

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ducated in perfect purity, and totally ignorant of pleasure, have felt the most lively impressions, without being able to recognise either their cause or their object? How many, on the contrary, remain cold and languid, notwithstanding all the efforts of sense and imagination?

This part of our bodies, therefore, belongs less to us than any other of our members. It acts or is languid without our participation. Its functions commence or terminate at certain periods. All this happens without our command, and often contrary to our inclination.

Where, then, is the foundation for those laws, which are so unjust in their principle, and so disgraceful in their execution? The rules and decrees of the Congress * are an affront to human reason. Its members should have known, that the very means they employed to investigate truth, were not only indelicate, but infallibly prevented its discovery.

When there is no defect in the external conformation, barrenness proceeds oftener from the woman than the man; for, independent of the pernicious effects of the fluor albus, there seems

* The name of an infamous court in France, where trials for impotency, with a view to dissolve marriages, were held. Proofs by inspection were taken before the judge, who was assisted by surgeons and midwives. This court was abolished by an arret of the parliament of Paris, dated 18th February 1677. It is surprising that the Count de Buffon, who expresses the utmost detestation against this court, should have mentioned nothing of its dissolution.

ſeems to be another cauſe which has never excited attention.

From my experiments, related in the ſixth chapter, it appears that the teſticles of females give birth to a kind of natural protuberances, which I have called *glandulous bodies*. They grow in a gradual manner, and ſerve for ſecreting and maturating the ſeminal fluid. They are in a continual fluctuating ſtate. They begin to grow under the membrane of the teſticle, which they ſoon perforate; they then ſwell, and their extremities ſpontaneouſly open, and diſtill a ſeminal fluid for ſome time; after which they gradually decay, leaving only a ſmall reddiſh cicatrice on the place from whence they ſprung. Theſe glandulous bodies no ſooner diſappear than they are replaced by others; ſo that the teſticles are continually labouring, and undergoing conſiderable changes. Hence any derangement in theſe organs, either by an unuſual thickneſs of the fluid, or weakneſs of the veſſels, prevents the proper exerciſe of their functions, renders them unable to ſecrete, or rather vitiates and corrupts the ſeminal fluid, which neceſſarily gives riſe to ſterility.

Conception ſometimes precedes puberty. Many women have become mothers before the appearance of the menſes; and ſome who never had any ſymptoms of this evacuation, are in the habit of bearing children. Inſtances of this kind happen in our climate, without travelling for

for them to Brazil, where whole nations are ſaid to be perpetuated, though not a ſingle woman be ſubject to the menſtrual diſcharge; an evident proof that it is not the menſtrual blood, but the ſeminal fluid of the male and female, which are eſſentially neceſſary to generation. It is likewiſe known, that the ceſſation of the menſes, which generally happens about the age of forty or fifty years, does not diſqualify every woman for conception; for ſome women have become pregnant at ſixty or ſeventy, and even at an age ſtill more advanced. Theſe examples, though pretty frequent, may be regarded as exceptions to the general rule; but they are ſufficient to demonſtrate that the menſtrual blood is by no means eſſential to generation.

In the ordinary courſe of Nature, women conceive not before the menſes appear, nor after they have ceaſed. The age at which men firſt acquire the faculty of generating is not ſo diſtinctly marked. His body muſt attain a certain growth before ſemen is ſecreted; and, before this fluid be fully maturated, the degree of growth muſt be ſtill greater. This generally happens between the twelfth and eighteenth years. But the period when man loſes the gegerative faculty, Nature ſeems to have left undetermined. At ſixty or ſeventy, when old age begins to enervate the body, the ſemen is leſs abundant, and often unprolific. In the collections of public ſocieties, however, there are many

many inſtances of men who have continued to procreate at the age of eighty and ninety.

There are likewiſe examples of boys who have procreated at eight, nine, and ten years, and of girls who have conceived at ſeven, eight, and nine years. But ſuch facts are exceedingly rare, and ought to be regarded as ſingular phaenomena. The ſign of virility appears in infancy: But that is not ſufficient; the production of ſemen muſt be added; and this happens not till the growth of the body is nearly compleated. At firſt the quantity is ſmall and generally ſterile.

Two marks of conception have been mentioned by authors. The firſt is a kind of tremor, or ſhivering, which is ſaid to begin at the moment of conception, and continues for ſome days. The ſecond is derived from the orifice of the uterus, which, it is aſſerted, cloſes entirely after conception. But theſe ſigns appear to be very equivocal, if not altogether imaginary.

This tremor is mentioned by Hippocrates in the following terms: 'Liquido conſtat harum 'rerum peritis, quod mulier, ubi concepit, ſta-'tim inhorreſcit ac dentibus ſtridet, et auricu-'lam reliquumque corpus convulſio prehendit.' Galen, on the authority of ſome women, imputes this ſymptom to the contraction of the uterus. Others expreſs it by a vague ſenſation of cold over the whole body, and employ the words *horror* and *horripilatio*. Theſe, and other authors,

thors, endeavour, like Galen, to eſtabliſh the fact upon the teſtimony of women. Hippocrates ſays, 'quae in utero gerunt, harum os uteri 'clauſum eſt;' or, according to another tranſlator, 'quaecunque ſunt gravidae, illis os uteri 'connivet.' Opinions, however, are various as to the changes which the uterus undergoes after conception. Some maintain, that the edges of the *os tincae* are drawn ſo cloſe together, that no vacuity is left between them; and others affirm, that theſe edges are not exactly cloſe till after the two firſt months of pregnancy. They agree, however, that, immediately after conception, the orifice is ſhut up by a glutinous humour; that the os tincae, which, previous to conception, might admit a ſubſtance of the ſize of a pea, has no perceptible aperture; and that this difference is ſo evident, as to be diſtinguiſhable by a ſkilful midwife. If theſe aſſertions were founded in truth, the ſtate of pregnancy might be known a few days after conception.

It is urged, on the other hand, that if, after conception, the orifice of the uterus were cloſed, ſuperfoetation would be impoſſible. To this it may be replied, that the ſeminal liquor may perhaps penetrate through the membranes of the uterus; that the uterus itſelf may open to receive the materials neceſſary for ſuperfoetation; and that, at any rate, ſuperfoetations ſo ſeldom happen, that they make a very trifling exception to the general rule. Other authors maintain,

maintain, that this change in the uterus can never appear but in women who have formerly conceived and brought forth children. In firſt conceptions, indeed, the difference muſt be leſs perceptible; but, though ever ſo conſpicuous, we have not ſufficient evidence to conclude, that it is a certain, a uniform, and a poſitive ſign. The ſtudy of anatomy, aided by experience, affords, on this ſubject, general notions only, which vaniſh upon a cloſer examination. The ſame obſervation may be applied to the ſhivering, or convulſive cold, which ſome women are ſaid to feel at the time of conception. As moſt women experience not this ſenſation; as others, on the contrary, aſſure us, that they have felt a burning heat; and as others ſtill confeſs that they are utter ſtrangers to all ſuch feelings; the natural concluſion is, that all theſe marks are highly equivocal, and that, when they do happen, they ought to be conſidered, not as the effects of conception, but of other cauſes.

On this ſubject I ſhall add one fact from Mr Parſons's lectures on muſcular motion, p. 79. which proves, that the orifice of the uterus does not cloſe immediately after conception, or, if it does cloſe, that the ſemen may find a paſſage into the uterus, by penetrating its ſubſtance. In the year 1714, a woman of Charleſtown in South Carolina, was delivered of two children, the one immediately after the other.

To the aſtoniſhment of the aſſiſtants, the one child was black and the other white. This evident teſtimony of the woman's infidelity to her huſband, obliged her to acknowledge, that, one morning, her huſband having juſt left her bed, a negro entered her chamber, and, by threats of immediate death, compelled her to gratify his deſires. This fact ſhows, that the conception of two or more children does not always happen at one time, and ſupports my opinion, that the ſemen penetrates through the texture of the uterus.

There are many other equivocal ſigns of pregnancy, by which it is ſaid to be early diſtinguiſhable; as a ſlight pain in the region of the uterus and loins; a numbneſs over the whole body; a continual drowſineſs; a melancholy and capricious diſpoſition; the toothach, headach; and a vertigo, which obſcures the ſight; yellowiſh, blood-ſhot eyes, with contracted pupils and depreſſed eye-lids; a pale and ſpotted countenance; a depraved appetite, accompanied with vomiting and ſpitting; hyſteric ſymptoms; the fluor albus; the ſtoppage of the menſtrual diſcharge, or, inſtead of it, an haemorrhage; the ſecretion of milk in the breaſts, &c. Many other marks ſuppoſed to be peculiar to pregnancy might be added; but they are frequently nothing more than the effects of particular diſeaſes. But we ſhall leave the diſcuſſion of theſe to phyſicians. Details of this kind, to be uſeful,

uſeful, would require a long ſeries of profound inveſtigation. This ſubject, like many others in phyſiology, in the animal oeconomy, and in different branches of the medical art, has ſeldom been treated with any degree of philoſophical accuracy.

SECT. III.

Of Manhood.

AT the age of puberty, or a few years after it, the human body attains its full ſtature. The growth of ſome perſons ſtops at the fourteenth or fifteenth year; and, in others, it continues till they arrive at twenty-two or twenty-three years. During this period, moſt men are of a ſlender make: Their thighs and legs are ſmall, and the muſcular parts are not properly filled up. But, by degrees, the muſcles ſwell, the limbs and different parts of the body aſſume their proper figure and proportions, and, before the age of thirty, the body, in men, acquires its moſt perfect ſymmetry.

But, in women, the body ſooner attains this ſymmetry. As their ſize is ſmaller, and their muſcles, and other parts, leſs ſtrong, compact, and ſolid, than thoſe of men, they arrive more early at a ſtate of maturity. A woman at twenty years is as perfectly formed as a man at thirty.

The body of a well-ſhaped man ought to be ſquare, the muſcles boldly marked, and the features of the face diſtinctly defined. In women, the parts are rounder and ſofter, and their features

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are more delicate. Man is adorned with ſtrength and majeſty; grace and ſoftneſs are the peculiar embelliſhments of woman.

Even the external figure of the human ſpecies declares them to be the ſovereigns of the earth. The body of man is erect; his attitude is that of command; and his countenance, which is turned towards the heavens, is impreſſed with the ſignatures of ſuperior dignity. The image of his ſoul is painted in his face; the excellence of his nature penetrates through his material form, and animates his features with a divine illumination. His majeſtic deportment, and the firmneſs of his movements, announce the ſuperiority of his rank. He touches the earth with his extremity only: He views it at a diſtance, and ſeems to deſpiſe it. His arms are not pillars to ſupport his body: His hands tread not the earth, and loſe not, by friction and preſſure, that delicacy of feeling for which they were originally deſtined. His arms and hands are formed for purpoſes more noble, namely, for executing the commands of his intellect, for laying hold of diſtant objects, for removing obſtacles, for defending him from injuries, and for ſeizing and retaining objects at pleaſure.

When the mind is at eaſe, all the features of the countenance are in a ſtate of profound tranquility. Their proportion, their harmony, their union, point out ſerenity of ſentiment, and accord with the calm that ſubſiſts within. When the ſoul, however, is agitated, the human viſage becomes a living canvas, upon which paſſions are repreſented with equal energy and delicacy; where every emotion is expreſſed by a correſpondent feature; where every impreſſion anticipates the will, and reveals, by obvious and pathetic characters, thoſe intentions and feelings which we are ſolicitous to conceal.

It is in the eyes that the paſſions are moſt ſtrongly marked, and moſt readily diſcovered. The eye belongs to the ſoul more than any other bodily organ. It participates of every mental emotion, the ſofteſt and moſt tender, as well as the moſt violent and tumultuous. It exhibits theſe emotions in all their force and purity, and infuſes into the ſoul of the ſpectator the fire and the agitation of that mind in which they originate. In fine, the eye reflects the light of thought, and the glow of ſentiment; it is the ſenſe of the underſtanding, and the language of intelligence.

Men who ſquint, or are ſhort-ſighted, have leſs of this external ſoul, (as it may be termed), whoſe chief reſidence is in the eye. Theſe defects hurt the phyſiognomy, and give to the fineſt countenance a diſagreeable, and often a ſtupid air. As nothing but ſtrong and violent paſſions are diſcoverable in viſages of this kind, and as they exhibit no marks of delicacy or vivacity of ſentiment, we are apt to form unfavourable impreſſions of ſuch perſons, which, however ill-

ill founded, it is difficult for us to efface. We are ſo accuſtomed to be influenced by external appearances, that, if no ſymptoms of thought and reflection appear in a man's countenance, we inſtantly decide him to be void of ability. We even draw concluſions from the cut of the clothes, or the curls of the periwig; neither are theſe concluſions always falſe. Men ought, therefore, to pay ſome attention to theſe minute articles; becauſe, in the eye of ſtrangers, they make a part of ourſelves, and contribute not a little to the judgments they form of our underſtanding and breeding.

A vivacious or a languid motion of the eye has a prodigious effect on the character of the countenance. Eyes are of different colours, dark hazel, light hazel, green, blue, gray, and whitiſh gray. The iris has a ſmooth velvet-like appearance, and conſiſts of many ſmall filaments, regularly diſpoſed, and directed towards the centre of the pupil. The moſt uſual colours of the eye are the hazel and the blue; and both theſe colours are ſometimes to be found in the ſame eye. The eyes commonly called black, when narrowly inſpected, are only of a dark hazel colour. They appear black in conſequence of their being contraſted with the white of the eye. Thoſe of a leſs deep hazel are likewiſe reckoned black, but are not equally beautiful. Shades of orange, hazel, gray, and blue, are frequently to be met with in the ſame eye; but,

but, wherever there is a blue tint, it becomes the prevailing colour, and outſhines all the reſt. The black and the blue are the moſt beautiful colours, and give moſt fire and vivacity of expreſſion to the eye. In black eyes their is more force and impetuoſity; but the blue excell in ſweetneſs and delicacy. The former dart forth a perpetual and uniform flame, becauſe their colour appears always the ſame, and reflects the ſame rays: But the modifications of light are diſtinguiſhable in the blue; becauſe different rays are reflected by the various tints of which they are compoſed.

Theſe, and other varieties in the colours of the eyes, are peculiar to man, the horſe, &c. In moſt other animals, the colours of individuals vary not. The eyes of the ox are brown; thoſe of the ſheep are of a watery colour; thoſe of the goat are gray, &c. Ariſtotle alledges, that, among men, gray eyes are the ſtrongeſt; that the blue are weaker; that prominent eyes are ſhort-ſighted; and that brown eyes ſee not ſo well as others in a faint light.

Though the eye, in moving, ſeems to be drawn towards either ſide, yet it only moves round its own centre, which gives the pupil the appearance of approaching or receding from the angles of the orbit, and of being elevated or depreſſed. In man the eyes are nearer each other than in any other animal. In ſome ſpecies, the eyes are ſo remotely ſituated, that it is impoſſible

poſſible for both eyes to ſee the ſame object at the ſame time.

Next to the eyes, the parts which give moſt character to the countenance are the eye-brows. Being totally different from every other feature, their effect is augmented by the contraſt: They form a deep ſhade in the canvas, and give relief to the other colours and features. The laſhes of the eye-lid have alſo their effect; when long and buſhy, they beſtow beauty on the eye, and give a mild and pleaſant aſpect to the face. Laſhes on both eye-lids are peculiar to man and the ape. Other animals have hair on the upper lid only; and, even in man, the laſh of the under lid is leſs than that of the upper. The eye-brows have only two movements; one by which they are elevated; and the other by which they are depreſſed and contracted.

The eye-lids guard the ball of the eye from duſt, inſects, &c. and keep the cornea moiſt. The upper eye-lid moves up and down; but the under lid has little or no motion. Although the motion of the eye-lids be ſubject to the will, yet, by ſleep, fatigue, or ſurpriſe, we loſe the command of them. They are ſometimes alſo affected with convulſive motions, which we are unable to reſtrain. In birds and amphibious quadrupeds, the under eye-lid alone moves; and fiſhes and inſects have no eye-lids either above or below.

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The forehead occupies a large part of the face, and contributes greatly to its beauty. It ſhould be well proportioned, neither too flat nor too prominent; neither too narrow nor too ſhort; and it ſhould be regularly adorned with hair both above and on each ſide. The hair gives great expreſſion to the countenance; baldneſs is therefore a capital defect; and the practice of employing ſuperficial hair, which is now ſo general, ought to be confined to ſuch as are naturally bald; for borrowed locks often change the true character of the face. If every man wore his own hair, and allowed it to float freely, it would be more eaſy to diſtinguiſh characters by the general aſpect of the countenance. The crown of the head, and immediately above the temples, are the parts which firſt become bald; but the hair below the temples, and on the under part of the back of the head, ſeldom falls off. Baldneſs is peculiar to man: Women, in the moſt advanced age, though their hair becomes white, are ſeldom affected with baldneſs: Children and eunuchs are not more ſubject to it than women; and the hair is ſtronger and more abundant in youth than at any other period. The longeſt hair becomes dry, and gradually waſtes and falls off as we advance in life. The whiteneſs commences at the points; and, when the hair is totally white, it loſes its ſtrength, and at laſt falls off altogether. There have been examples of young people whoſe hair was rendered white by diſeaſe, and which recovered its natural colour after their health was reſtored. It is alledged by Ariſtotle, that no man becomes bald before having intercourſe with women, except ſuch as have been bald from their birth. The ancient writers upbraid the inhabitants of the iſlands of the Archipelago with the epithet *bald-heads*; and aſſert, that theſe iſlanders are all brought into the world with this defect *.

The noſe is the moſt prominent feature in the face. But, as it has very little motion, even in the moſt violent paſſions, it contributes more to the beauty than to the expreſſion of the countenance; and, unleſs it be deformed, or greatly diſproportioned, it is leſs attended to than thoſe features which are capable of motion, as the mouth and the eyes. The form of the noſe, and its remarkable prominency, are peculiar to the human ſpecies. Moſt animals have noſtrils ſeparated by a partition; but none of them have an elevated and advanced noſe. Even the apes may be ſaid to have noſtrils only; the noſe of an ape has the ſame poſition as that of a man; but it is ſo ſhort and flat, that it can hardly be regarded as ſimilar.—By this organ, men, and moſt animals, breathe, and ſmell odoriferous bodies. Birds have no cartilaginous noſtrils; they have only two holes or pipes for the purpoſes of reſpiration and ſmelling.

Next

* See Dapper's Voyage, p. 354. and Plin. edit. Hardouin, p. 541.

Next to the eyes, the mouth and lips have both the greateſt motion and expreſſion. Theſe motions are excited by the paſſions, and the various forms of the mouth mark their different characters and modifications. The organs of ſpeech give the mouth an animation ſuperior to every other part of the face. The vermilion of the lips, and the whiteneſs of the teeth, ſo much excel the other colours of the face, that they attract our chief regard. We fix our eyes on the mouth of the ſpeaker; every word, every articulation, produces different motions on the lips; and, however rapid, it is eaſy to diſtinguiſh them from each other. The deaf learn to diſtinguiſh theſe motions ſo accurately, that they often know the ſentiments of the ſpeaker merely by attending to the motions of his lips.

In man, and in all other animals, the under-jaw is alone endowed with the power of motion. The crocodile, the opinion of Ariſtotle and many other naturaliſts notwithſtanding, is not an exception: I have examined many ſkeletons of that animal, and have found, by the nature of the articulation, that the under-jaw alone was moveable. In the human foetus, and in monkeys, the under-jaw is greatly advanced before the upper. The deformity, in adults, is equal, whether the under-jaw be too prominent, or too much depreſſed: It ought to be nearly on a level with the upper. Strong paſſions, as well as languor, often produce an involuntary

motion

motion in the under-jaw: Pain and pleaſure, as well as languor, give riſe to yawning; but, in the former, the motion is more briſk and lively.

When the mind is ſuddenly affected with ardent deſire, or keen regret, we feel a ſort of ſtarting, or internal oppreſſion; this motion of the diaphragm elevates the lungs, and produces that ſudden inſpiration which forms a ſigh: And, when the mind conſiders the cauſe of its emotion, and perceives no method of accompliſhing its deſire, or of baniſhing its regret, the ſighs are repeated, and ſorrow, or mental pain, ſucceeds. If this pain of mind be great and unexpected, it produces tears; the air ruſhes quickly into the lungs, and gives riſe to many inſpirations, which are accompanied with involuntary ſhocks: Each inſpiration makes a noiſe ſtronger than that of ſighing, and is diſtinguiſhed by the name of ſobbing; theſe ſobs ſucceed each other more rapidly than ſighs; and, in the former, the ſound of the voice is more apparent. The accent of the voice is ſtill more diſtinguiſhable in groaning, which is a ſpecies of ſob long continued; and its ſlow ſound is heard both in expiration and inſpiration: Its expreſſion conſiſts in the continuation of a plaintive tone formed by inarticulate ſounds. Groans are ſhorter or longer according to the degree of ſorrow or dejection; but they are generally repeated ſeveral times. The time of inſpiration forms the interval that takes place between each groan;

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and the intervals are nearly equal both in their duration and their diſtance. The plaintive ſhriek is a groan expreſſed with force, and with a high tone of voice. The ſhriek, when very ſharp, generally continues on the ſame tone through its whole extent; but, when moderate, it commonly ends in a lower tone.

Laughter is an interrupted ſound, often repeated, and accompanied with a kind of convulſive motion of the belly, which is alternately elevated and depreſſed. To facilitate this motion, the breaſt and head are ſometimes thrown forward; the cheſt remains immoveable; the angels of the mouth recede from each other; and the cheeks ſwell: Every time that the belly is depreſſed, the air burſts from the mouth, and occaſions a noiſe, which, during the fit, is often repeated, ſometimes on the ſame tone, and ſometimes the tones gradually diminiſh.

The lips, in immoderate laughter, and in moſt violent paſſions, open wide; but, in the more tranquil emotions, the angles of the mouth recede, without any opening of the lips, the cheeks ſwell, and, in ſome perſons, dimples are formed in them near the corners of the mouth: This charm belongs to the graces, and is commonly attended with an agreeable ſmile, which is a mark of benevolence, and of internal ſatiſfaction: A ſmile is alſo a mode of expreſſing contempt and ridicule; but, in theſe malignant ſmiles, we preſs the lips cloſe to each other.

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The cheeks are uniform features, and have little motion or expreſſion, except from that involuntary redneſs or paleneſs with which they are covered in different paſſions; they unite the features, and give a contour to the face; they contribute more to beauty than to expreſſion; and the ſame obſervation may be applied to the chin, the ears, and the temples.

Shame, anger, pride, joy, equally give riſe to bluſhing; while fear, terror, and ſorrow, produce a paleneſs in the face. This change of colour is involuntary; it exhibits the ſtate of the mind without its conſent. It is an effect of ſentiment over which the will has no command. We can eaſily diſguiſe the other marks of paſſion; for a moment's reflection enables us to ſtop the action of the muſcles of the face which characteriſe particular paſſions, and even to change their direction; but to ſtop or alter the redneſs or paleneſs of the countenance, is beyond our power; becauſe theſe depend on a peculiar motion of the blood, occaſioned by the action of the diaphragm, which is the chief internal organ of ſenſation.

In different paſſions, the whole head is affected with different motions and poſitions: It hangs forward during ſhame, humility, and ſorrow; it inclines to one ſide in languor and compaſſion; it is elevated in pride, erect and fixed in obſtinacy and ſelf conceit; it is thrown backward in aſtoniſhment or ſurpriſe; and rolls from

ſide

ſide to ſide in contempt, ridicule, and indignation.

Grief, joy, love, ſhame, and compaſſion, make the eyes ſwell, and cauſe the tears to flow. The effuſion of tears is always accompanied with a contraction of the muſcles of the face, which opens the mouth; the tears flow through the lachrymal ducts into the noſe, and increaſe the fluid with which it is naturally moiſtened: The flowing of the tears is not conſtant; they ſeem to burſt out at irregular intervals.

In grief, the corners of the mouth are depreſſed, the under-lip riſes, the eye-lids fall down, the pupil is elevated, and half concealed under the eye-lid: The other muſcles of the face are relaxed, which enlarges the ſpace between the mouth and the eyes; and, of courſe, the countenance appears to be ſtretched out beyond its ordinary length. (See plate X. fig. 1.)

In conſternation and terror, the brow is wrinkled, the eye-brows are elevated, the upper eye-lid opens ſo wide that it riſes above the pupil, and uncovers a part of the white above the pupil, which laſt falls down, and is partly concealed by the under-lid. The mouth, at the ſame time, opens wide, the lips recede from each other, and expoſe the teeth both above and below. (See plate X. fig 2.)

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In contempt and derision, one corner of the upper-lip rises, and leaves the teeth bare; the other corner moves a little, and has the appearance of a malignant smile; the nostril next the elevated side of the lip shrivels up, and the angle of the mouth falls down. The eye on the same side is almost shut, while the other remains open; and both pupils are depressed in the same manner as when a person looks down from a height. (See plate X. fig. 3.)

In jealousy, envy, and malice, the eye-brows fall down and are wrinkled; the eye-lids rise, and the pupils fall down; the upper lip is elevated on both sides; the angles of the mouth sink a little, and the middle of the under-lip rises and joins the middle of the upper one. (See plate X. fig. 4.)

In laughing, the angles of the mouth are drawn back, and somewhat elevated; the upper part of the cheeks rise; the eyes are more or less shut; the upper lip rises and the under one sinks; the mouth opens; and, when the laughter is immoderate, the skin of the nose wrinkles. (See plate X. fig. 5.)

Beside these marks, the arms, the hands, and the whole body, contribute to the expression of the passions. Gesture also concurs with the action of the features in expressing the different emotions of the soul. In joy, for example, the eyes, the head, the arms, and whole body, are agitated with quick and various movements. In langour and grief, the eyes are ſunk, the head reclines, the arms hang down, and the whole body remains fixed and immoveable. In admiration, ſurpriſe, and aſtoniſhment, every motion is ſuſpended, and the perſon remains in the ſame uniform attitude. Theſe expreſſions of the paſſions are involuntary: But there is another ſpecies of expreſſion, which conſiſts in an agitation of the eyes, head, arms, and body; and theſe motions ſeem, at the ſame time, to be the effect of reflection, and to depend on the will. They appear to be efforts of the mind to defend the body, and may be regarded as ſecondary ſymptoms, by which particular paſſions may be diſtinguiſhed. In love, hope, and keen deſire, we elevate the head, and turn towards heaven, as if imploring poſſeſſion; we ſtretch forward the head to make a nearer approach; and we extend the arms and open the hands, in order to ſeize and embrace the beloved object. On the other hand, in fear, hatred, and horror, we puſh the arms forward with precipitation, to repel the object of our averſion; we turn back the head and the eyes; we recoil, and at laſt fly, in order to avoid it. Theſe motions are ſo ſudden, that they appear to be involuntary: But this deception is the effect of habit; for theſe motions are produced by reflection, and, by their alacrity, diſcover the perfection of thoſe qualities of the body which enable it to obey, with ſuch amazing promptitude, the commands of the mind.

Plate X

A Bell Sculp.

As the paſſions are agitations or movements of the mind, for the moſt part connected with impreſſions of ſenſation, they may be expreſſed by motions of the body, and particularly by thoſe of the countenance. We can, therefore, form a judgment of the affections of the mind by the motions of the body, and can diſcover the real ſituation of the ſoul by examining the changes in the features of the face. But, as the mind has no figure which can have any relation to that of matter, we can form no judgment of the general diſpoſition of any mind by the features of the countenance, or by the figure of the body with which it is connected. A deformed body may contain an amiable mind; neither ſhould we pronounce concerning the natural diſpoſition of any perſon, merely becauſe the features of his countenance are not agreeable; for there is no analogy between features and the nature of the ſoul, upon which any reaſonable conjectures can be founded.

The ancients, however, were much addicted to this falſe notion; and there have not been wanting in every age, men who wiſhed to ſupport a ſcientific divination derived by a pretended ſkill in phyſiognomy. But nothing is more evident, than that this ſpecies of divination can be extended no farther than to the affections of the mind, when expreſſed by the motion of the eyes, viſage, and other parts of the body: The form of the noſe, of the mouth,

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and of other features, has no more connection with the natural disposition of any person, than the stature, or size of the limbs, with the faculty of thinking. Has a man more genius in proportion as his nose is well made? Is the ability of another more circumscribed, because his eyes are small and his mouth large? It must, therefore, be acknowledged, that the divination of physiognomists is altogether chimerical, and destitute of any foundation in nature.

The ears, of all the parts of the head, contribute least to the expression of the face. They are placed at a side, and commonly concealed under the hair. But, in quadrupeds, the ears are more apparent; and by them we can discover whether the creatures be in a state of vigour or of imbecility; their motions denote sentiment, and correspond to the internal feelings of the animal. The human ears, though furnished with muscles, have hardly any motion, either voluntary or involuntary. Small ears are said to be most beautiful; but large ones are better calculated for hearing. Some nations greatly enlarge the lobs of their ears, by piercing them, and placing in them pieces of wood or metal, which they change successively for others of greater dimensions, till the holes become enormous; and the lobes uniformly increase in proportion to the size of the holes. I have seen these round pieces of wood, which had been brought from India or south America, of more than an inch

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and a half in diameter. It is difficult to investigate the origin of this ſingular cuſtom; but it is equally difficult to trace the origin of piercing the ears, (a practice almoſt general), and ſometimes the noſtrils, in order to adorn them with rings, &c. unleſs we attribute it to thoſe naked ſavages, who contrived to carry, in the leaſt incommodious manner, ſuch things as appeared to them to be moſt precious.

But the whimſical varieties in the cuſtoms of different nations are ſtill more apparent in the manner of dreſſing and wearing their beards. The Turks ſhave their heads; but allow their beards to grow. Moſt Europeans, on the contrary, ſhave their beards, and wear their own or borrowed hair. The ſavages of America pull out the hairs of their beards, but carefully preſerve thoſe of the head. The Negroes ſhave their heads in different figures; ſometimes they cut their hair in the ſhape of little ſtars, ſometimes in the manner of a friar, but moſt commonly in alternate ſtripes. The Talapoins of Siam ſhave the heads and eye-brows of thoſe children whoſe education is entruſted to them. In this article every nation has different uſages. Some prefer the hair on the upper lip to that of the chin; others eſteem hair on the cheek; ſome curl it, and others wear it ſtraight. It is not long ſince we wore our hair behind looſe and floating; we now incloſe it in a bag. Our dreſs is different from that of our fathers. The differences in drefs is as various as the different nations of the globe: And, what is fingular, we have adopted that drefs which is moft incommodious, waftes moft time in adjufting, and is leaft agreeable to Nature.

Though fafhions feem to be founded on caprice and fancy; yet, when generally adopted, they merit examination. Men have always given a value to thofe things which excite attention, and which convey flattering ideas of riches, power, and grandeur. The value of diamonds, and other precious ftones, arifes from their fcarcenefs and brilliancy. The fame obfervation applies to thofe fhining metals, the weight of which we regard fo little, that, for the fake of finery, we fpread them over our garments. Ornaments of this kind are intended to excite the attention of fpectators, to give them an idea of fplendour and wealth, and to dazzle their fancies: How few have the capacity of diftinguifhing the perfon from the drefs, or of eftimating the man in any other manner than by the metal on his clothes?

Every thing that is rare and brilliant will, therefore, always be fafhionable, while men derive more eminence from riches than virtue, and while the means of acquiring refpect continue fo widely different from real merit. Strangers receive their firft impreffions of us from our drefs, which is varied according to the points of view in which we wifh to be confidered. The

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modeſt man, or he who wiſhes to aſſume that character, dreſſes with a ſimplicity correſponding to the nature of that virtue. The vain-glorious, on the contrary, neglect nothing that can ſupport their pride or flatter their vanity; and they diſtinguiſh themſelves by ſplendour or fineneſs in their external appearance.

Another very general object of dreſs is to increaſe the ſize of our figure, and to occupy more room in the world than Nature has allotted to us. We wiſh to enlarge our dimenſions by high-heeled ſhoes and blown up garments; but, however bulky our dreſs, it is exceeded by that vanity which it endeavours to cover. Why is the doctor's head loaded with an enormous quantity of borrowed hair, while that of the beau is ſo thinly covered? The former wiſhes to have the extent of his learning meaſured by the apparent dimenſions of his head; and the latter deſires to diminiſh his head, that he may exhibit the gaiety and ſprightlineſs of his genius.

Other faſhions appear to have a more rational object, namely, to conceal the defects of Nature, or to render them leſs diſagreeable. Taking mankind in general, there is a greater number of deformed bodies, and diſagreeable faces, than of handſome figures, and beautiful countenances. Faſhions are always regulated by the practice of the majority; and, as the greateſt part of mankind have defects to conceal, it is their intereſt to invent and ſupport thoſe modes

which

which tend to render their deformities lefs confpicuous. Women never think of paint, till the natural bloom of their cheeks is faded. Painting, however, is a very general cuftom. The mode of whitening the hair * with powder, and curling it, is not fo univerfal; but it feems to have been intended for the fame purpofe, to make the colours and features of the countenance appear with greater advantage.

But, leaving external ornaments, and the drapery of the picture, let us return to the figure itfelf. The head of man is differently conftructed, both internally and externally, from that of any other animal. The head of the monkey makes the neareft approach; its brain, however, is proportionally lefs; and there are other differences, to be afterwards pointed out. The bodies of almoft all quadrupeds are entirely covered with hair. In man, the head alone has this ornament before the age of puberty, and it is more amply furnifhed with hair than the head of any other animal. The monkey refembles man very much in his ears, nofe, and teeth.

Among animals, there is a great diverfity in the fize, pofition, and number of their teeth. Some are furnifhed with teeth in both jaws; others have them in the under-jaw only; in fome they are widely feparated from each other; and

* The favages of New Guinea powder their heads and beards with chalk. See Recueil des Voyages, &c. tom. 4. p. 637.

and are cloſe and united in others. The palate of ſome fiſhes is a hard bony plate, ſtuck full of ſharp points, which perform the office of teeth.

The mouths of moſt animals are armed with ſome ſolid ſubſtance, which enables them to apprehend or grind their food. The teeth of men, quadrupeds, and fiſhes, the beaks of birds, the pinchers, ſaws, &c. of inſects, are all hard inſtruments, and, like the nails, horns, and hoofs, derive their origin from the nerves. We formerly remarked, that nerves, when expoſed to the air, acquire a ſurpriſing hardneſs. As the mouth gives a free acceſs to the air, it is therefore natural to think that the nerves which terminate there ſhould harden, and produce the teeth, the bony plate, the beak, the pinchers, and all the other ſolid parts of animals.

The neck ſupports the head, and unites it to the body. It is larger and ſtronger in moſt quadrupeds than in man. Fiſhes, and other animals which are not furniſhed with lungs ſimilar to ours, have no neck. Birds, in general, have longer necks than other animals. Thoſe birds which have ſhort claws have likewiſe ſhort necks, and *vice verſa*. Ariſtotle ſays, that birds of prey which have pounces are all ſhort necked.

The human breaſt is proportionally larger than that of other animals; and none but man and the monkey have collar-bones. The breaſts of women are larger and more promi-

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nent than thofe of men: But their confiftence and ftructure are nearly the fame; for the breafts of men can fecrete milk. There are many examples of this fact; and it commonly happens at the age of puberty. I have feen a young man of fifteen years fqueeze more than a fpoonful of milk out of one breaft. Among animals there is a great variety in the number and fituation of their paps. Some, as the monkey and elephant, have only two placed on the fore part of the breaft; others have four, as the bear; others, as the fheep, have only two fituated between the hinder legs; others have them in great numbers upon the belly, as the bitch and the fow. Birds, and all the oviparous animals, have no paps. Viviparous fifhes, as the whale, the dolphin, &c. have breafts, and fuckle their young. The form of the breafts varies in different animals, and even in the fame animal at different ages. It is alledged, that women, whofe breafts are fhaped like a pear, make the beft nurfes, becaufe the mouth of the child comprehends not only the nipple, but part of the breaft itfelf.

Below the breaft is the belly, in which the navel makes a confpicuous figure. In other animals it is hardly perceptible; and even the monkey has nothing in place of it but a kind of callofity.

The arms of man have little refemblance to the fore feet of quadrupeds, and ftill lefs to the wings of birds. The monkey tribe are the only animals which have arms and hands; but their ſtructure is more rude, and their proportion leſs exact than thoſe of man; his ſhoulders are likewiſe larger, and differently conſtructed from thoſe of any other animal; and it is on the top of the ſhoulders that he can bear the heavieſt burdens.

The form of the back differs not much from that of ſome quadrupeds; the region of the reins is indeed more muſcular and ſtrong. But the buttocks are peculiar to the human body; the thighs of quadrupeds are often miſtaken for the buttocks, though they be totally different. Man being the only animal who can ſupport himſelf perfectly erect, the ſwelling, or cuſhion on the top of his thighs, is neceſſary to ſuſtain him in that poſture.

The human foot is very different from that of all other animals, the monkey not excepted. The foot of the ape is rather a kind of hand; its toes are long, and ſituated like fingers, the middle one being by much the longeſt; and it has no heel. The ſole of the foot is likewiſe larger in man, and his toes are better adapted for preſerving the equilibrium of the body in walking, running, dancing, and other movements.

The human nails are leſs than thoſe of other animals. If they protruded much beyond the points of the fingers, they would obſtruct the dexterity of the hand. Thoſe ſavages who al-

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low them to grow to an unnatural length, uſe them for flaying and tearing animals. But, although their nails be ſtronger and longer than ours, they can by no means be compared to the hoofs or claws of other animals.

With regard to the proportions of the human body, we have no exact knowledge. The ſame parts have not the ſame proportions in any two individuals; and, even in the ſame perſon, the correſponding parts are not perfectly ſimilar. For example, the right arm or leg have ſeldom the ſame dimenſions with the left. Repeated obſervations alone can aſcertain a ſtandard by which we may be enabled to form a perfect idea of the natural and beſt proportions of the human figure. It is not by comparing men, or taking their dimenſions, that we are to expect any light upon this ſubject: We have more to hope from the art of deſigning, and the efforts which have been made in imitating Nature. Taſte and ſentiment have exceeded the limits of mechanical operations. The ſquare and compaſs are laid aſide, and we truſt more to the impreſſions made on the ſenſes. Every poſſible form has been realized in bronze or in marble. We recogniſe the ſtandard of Nature more by imitating her, than by her own productions; and we judge better concerning the perfection of a ſtatue by viewing it, than by taking its different dimenſions. It is by long practice in the art of deſigning, and by deli-

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cacy of ſentiment, that eminent ſtatuaries have been enabled to make men feel the juſtneſs of proportion in the works of Nature. The ancients made ſtatues ſo exquiſitely fine, that they have uniformly been regarded as exact repreſentations of the moſt perfect human figures. Theſe ſtatues, which were only copies of the human form, are now conſidered as originals; becauſe they were not imitated from an individual, but from the whole ſpecies, ſo attentively compared and diligently obſerved, that it is impoſſible to find an equal degree of ſymmetry and proportion in any one man that ever exiſted. We ſhall, therefore, relate the dimenſions of the different parts which theſe artiſts have fixed as ſtandards of perfection. They commonly divide the height of the body into ten times the length of the face; they likewiſe divide each *face*, or tenth of the body, into three equal parts; the firſt commences at the ſpringing of the hair on the forehead, and terminates at the root of the noſe; the noſe is the ſecond diviſion; and the third extends from the noſe to the end of the chin. In meaſuring the reſt of the body, they uſe the term *noſe*, or length of the noſe, to denote the third of a face, or the thirtieth part of the body. The firſt face begins at the root of the hair above the forehead, and extends to the end of the chin; but, from the top of the forehead to the crown, there is ſtill a third of a face, or a noſe, in height. Thus, from

from the top of the head to the end of the chin, there is a face and a third; from the chin to the juncture of the clavicles, two thirds of a face; and, therefore, from the top of the breaſt to the crown of the head, is twice the length of the face, or the fifth of the body; from the joining of the clavicles to the under part of the paps, they reckon one face; from this to the navel is a fourth face; and the fifth extends from the navel to the diviſion of the inferior extremities, which ſhould complete half the length of the body. Two faces are exhauſted between the thigh and knee, to the laſt of which they allow half a face, being the firſt half of the eighth face; two faces are aſſigned between the knee and top of the foot, and from that to the ſole half a face, which completes the ten faces, or length of the body. This diviſion has been made from men of ordinary ſize; but, in thoſe of a higher ſtature, they allow about half a face additional between the paps and the commencement of the thighs, which, in tall men, is not the middle of the body. When the arms are fully ſtretched in a horizontal line, the ſpace between the tops of the middle fingers is equal to the length of the body. From the joining of the collar-bone to the articulation of the ſhoulder-bone with that of the arm, is one face. When the arm hangs down, or is bended forward, it is four faces in length; two between the joint of the ſhoulder and the elbow, and

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two between the elbow and the root of the little finger, in all five faces, and an equal number for the other arm, which is precisely the length of the body; about half a face remains for the length of the fingers; but it must be remarked, that half a face is lost in the joints of the elbows and shoulders, when the arms are extended. The hand is about a face in length, the thumb a third of a face, or a nose, and the longest toe is of the same length with the thumb. The under part of the foot is equal in length to the sixth part of the height of the body. For the reasons already mentioned, if an experiment be made of these dimensions upon any individual, they will appear to be extremely imperfect. It is still more difficult to fix the proportional thickness of the different parts of the body. The changes are so great when the same man is meagre or in good case, and the action of the muscles in different positions, creates so much variety in the dimensions of the parts, that it is almost impossible to give any determined rules upon this subject.

The superior parts of the body, in infancy, are larger than the inferior; the thighs and legs are not nearly equal to half the length of the whole body; as the child advances in years, the inferior parts grow more in proportion than the superior; and, when the growth is complete, the thighs and legs are very nearly one half the length of the body.

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The anterior parts of the cheſt, in women, is more elevated, and its diameter larger, than in men; but the cheſts of the latter are proportionally broader. The haunches of women are likewiſe larger than thoſe of men; becauſe the haunch-bones of women, and thoſe which join them and compoſe the pelvis, are proportionally larger. Theſe differences in the ſtructure of the cheſt and pelvis are ſo perceptible, that it is eaſy, by this criterion, to diſtinguiſh the ſkeleton of a woman from that of a man.

There are great varieties in the length of men. Thoſe are ſaid to be tall who are from five feet eight inches to ſix feet high. The middle ſtature is from five feet five to five feet eight; and thoſe who fall below theſe dimenſions are ſaid to be of ſmall ſtature. Women, in general, are two or three inches below the ſtandard of men. Of giants and dwarfs, notice ſhall be taken in another place.

Though the human body be externally more delicate, it is, however, very nervous, and perhaps ſtronger, for its ſize, than the moſt robuſt quadruped. In comparing the force of a lion to that of a man, it ought to be conſidered, that the lion is armed with teeth and talons; and that theſe dreadful weapons convey a falſe idea of real ſtrength. The arms which man has received from Nature are not offenſive; and happy had it been if art had never put into his hands

hands weapons more deſtructive than the claws of the lion.

But there is a juſter method of inſtituting a compariſon between the ſtrength of a man and that of the other animals, namely, by the weight they are able to carry. It is affirmed, that the porters of Conſtantinople can carry burdens of nine hundred pounds weight; and Deſaguliers tells us, that, by means of a certain harneſs, by which every part of a man's body was proportionably loaded, the perſon he employed in this experiment was able to ſupport, in an erect poſture, a weight not leſs than 2000 pounds. A horſe, which is about ſix times the ſize of an ordinary man, ought, therefore, when managed in the ſame manner, to bear 12,000 or 14,000 pounds; an enormous weight, in compariſon of what that animal can ſupport, even when it is diſtributed with every poſſible advantage.

The ſtrength of animals may likewiſe be eſtimated by agility and perſeverance in labour. Men, when accuſtomed to running, outſtrip horſes, or at leaſt continue their ſpeed much longer; and a man will accompliſh a long journey ſooner, and be leſs fatigued, than even the beſt road horſes. The royal meſſengers of Iſpahan, who are trained to running, go 36 leagues in 14 or 15 hours. We are aſſured by travellers, that the Hottentots outrun lions in the chace; and that thoſe ſavages who live upon hunting, purſue and even catch deer, and other animals of equal ſwiftneſs. Many other ſtories are told of the amazing nimbleneſs of ſavages, of the long journeys they accompliſh on foot, over the moſt craggy mountains, where there is no path to direct, and every obſtacle to obſtruct their progreſs. Theſe people are ſaid to travel 1000 leagues in ſix weeks, or at moſt two months. If we except birds, whoſe muſcles are proportionally ſtronger than thoſe of any other animal, no other creature could ſupport ſuch long continued fatigue. The civilized man is ignorant of his own ſtrength; nor is he ſenſible how much he is weakened by effeminacy, nor to what extent he might recover his native force by an habitual and vigorous exerciſe of his powers.

Men of extraordinary ſtrength ſometimes appear *. But this gift of nature, which would be highly valuable in the ſavage ſtate, is of little uſe among poliſhed nations, where more depends on mental than corporeal powers, and where manual labour is confined to the inferior orders of men.

Men are much ſtronger than women; and they have too often employed this ſuperiority in exerciſing a cruel and tyrannical dominion over the weaker ſex, who were entitled to ſhare with them both the pleaſures and the pains of life. Savage nations condemn the women to perpetual

* Nos quoque vidimus Athanatum nomine prodigioſae oſtentationis quingenario thorace plumbeo indutum, cothurniſque quingentorum pondo calcatum, per ſcenam ingredi. Plin. lib. 7.

tual labour. They cultivate the ground, and perform every office of drudgery, while the men indolently recline in their hammocks, from which they never think of ſtirring, unleſs when they go a hunting or fiſhing; and, ſo averſe are they to motion, that they have often been known to ſtand in the ſame poſition for ſeveral hours. A ſavage has no idea of walking for amuſement; and nothing aſtoniſhes him more than to ſee Europeans walking backwards and forwards in queſt of nothing. All men are naturally indolent; but the ſavages of warm countries are not only the moſt lazy of human beings, but the moſt tyrannical to their women, whom they treat with a cruel barbarity. In nations more civilized, men dictate laws to the women. Theſe laws are always more ſevere in proportion to the groſſneſs of the national manners; and it is only among people highly poliſhed that women have obtained that equality of condition which is due to them, and which contributes ſo powerfully to the happineſs of ſociety. This politeneſs of manners is the genuine offspring of the ſofter ſex; they have oppoſed it to the arms of the victor, while their modeſty has taught us to acknowledge the empire of beauty, a natural advantage greatly ſuperior to mere ſtrength. But, to give it full force and value, requires the aſſiſtance of art; for the ideas of beauty are ſo different, ſo capricious, and even contradictory, that the women, it is probable, have gained more

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by the art of making themſelves amiable, than by beauty itſelf, of which men form ſuch oppoſite judgments. Men are agreed as to the ultimate object of their paſſion for the other ſex, the eſtimation of which is augmented by the difficulty of acquiſition. The beauty of women commenced the moment they learned to make themſelves reſpectable, by refuſing all approaches to their hearts which proceeded not from delicacy of ſentiment; and, whenever the influence of ſentiment was felt, poliſhed manners was a neceſſary conſequence.

The taſte of beauty, among the ancients, differed widely from ours. With them, a ſmall fore-head and joined eye-brows were charming features in a female countenance; and, in Perſia, large joined eye-brows are ſtill highly eſteemed. In ſome Indian countries, black teeth and white hair are neceſſary ingredients in the character of a beauty; and in the Marian Iſlands it is a capital object with ladies to blacken their teeth with herbs, and to bleach their hair with certain liquors. Beauty, in China and Japan, is compoſed of a large countenance, ſmall and half concealed eyes, a broad noſe, minute feet, and a prominent belly. Some Indians of America and of Aſia compreſs the heads of their children between two wooden planks, with a view to enlarge and beautify the face; others compreſs them laterally, others depreſs the crown only, and others make the head as round as poſſible

ſible. Every nation has ideas of beauty peculiar to itſelf; and every individual has his own notions and taſte concerning that quality. Theſe peculiarities probably originate from the firſt agreeable impreſſions we receive of certain objects; and therefore depend more upon chance and habit than upon difference of conſtitution. When we come to treat of the ſenſes, we ſhall perhaps be able to give more determined ideas concerning thoſe perceptions of beauty we receive by the eye.

SECT. IV.

Of Old Age and Death.

EVERY object in Nature muſt change and decay. The bodies of men no ſooner arrive at full maturity, than they inſtantly begin to decline. The waſte is at firſt inſenſible; ſeveral years frequently revolve before we perceive any conſiderable alteration. But we ought to feel the weight of our years, better than their number can be eſtimated by ſtrangers; and, as thoſe are ſeldom deceived who judge of our age by external characters, we would be ſtill more ſenſible of it from what paſſes within us, if we were more attentive to our feelings, and deceived not ourſelves by vanity and fallacious hopes.

When the body has acquired its full length, it increaſes in thickneſs: The commencement of this augmentation is the firſt ſtep towards decay; for this extenſion is not a continuation of growth, which would communicate force and activity, but merely an addition of ſuperfluous matter, that blows up the body, and loads it with a uſeleſs weight. This matter, which

which is denominated fat, generally appears at the age of 35 or 40 years; and, in proportion as the quantity of it augments, the body loses its former lightness and freedom of motion; its generative faculty is diminished; its members turn unwieldy; and it acquires extension at the expence of strength and activity.

Besides, the bones increase in solidity; the nutritious juices, which formerly served to expand the bones, now increase their quantity of matter only, by filling up their internal cavities; the membranes are changed into cartilages, and the cartilages into bones; the fibres of the muscles grow rigid; the skin is deprived of its moisture, and wrinkles are gradually formed in it; the hair turns hoary; the teeth fall out; the visage assumes a haggard appearance, the body bends forward, &c. The first approaches of this state are perceptible before the age of 40; they advance by slow degrees till 60, and more rapidly from that to 70, when decrepitude commences, and continues to augment till 90 or 100, when death puts a final period to our existence.

We shall now take a more particular survey of these changes; and, as we have inquired into the causes of the growth and expansion of the human body, let us also investigate those of its decay and dissolution. At the commencement of our existence, the bones are only small fibres, of a soft and ductile substance, and gradually acquire consistence and solidity. They may be

considered

confidered, in their original ftate, as fmall tubes lined, both within and without, with a thin membrane: This double membrane furnifhes the offeous matter; for the fmall interval between the internal and external periofteum is foon converted into a bony plate. Some idea of the production and growth of bones may be formed, by comparing them with the manner in which wood and the more folid parts of vegetables are produced. We fhall take, for example, the fig-tree or the alder, which are at firft hollow in the middle, like the thigh and other hollow bones of the body. When a bud, that is to form a branch, begins to extend, it is only a foft ductile matter, which, by extenfion, becomes a flender herbaceous tube filled with pith. The external and internal furfaces of this tube are covered with a fibrous membrane, as well as the internal partitions by which the cavity is divided. Thefe membranes, however thin, are compofed of feveral plates of fibres lying above each other, which are ftill foft, but gradually harden by depofiting the fap which they abforb for their nourifhment; and by this means a woody plate is formed, during the firft year, between the two membranes, which is more or lefs thick in proportion to the quantity of fap that has been depofited between the external and internal membranes. But, though each of thefe membranes become woody internally, their external furfaces remain foft

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and ductile; and, the following year, when the bud at the top of the branch begins to expand, the ſap riſes through the ſoft fibres of each membrane, and converts them, by its ſediments, into other woody plates. The ſame proceſs goes on annually; and, in this manner, the tree or branch gradually increaſes in thickneſs. The internal cavity likewiſe augments in proportion to the growth of the branch; becauſe the internal membrane extends along with the other parts, and the woody plates are only applied ſucceſſively to the plates already formed. If we examine a branch, or a joint, which has been the product of one year, we ſhall find, that it uniformly preſerves the ſame figure through all the ſtages of its growth. The joints or knots which mark the production of each year, become fixed points for the reaction of thoſe powers that expand the contiguous parts during the following year. The ſuperior buds react againſt theſe points, and, by expanding themſelves, form new branches or joints in the ſame manner as the firſt were produced.

The proceſs of oſſification would be very ſimilar to that we have now deſcribed, if the fixed points of the bones began at the extremities, in place of the middle. At firſt the bones of the foetus are only ſmall threads, or tubes, of a ductile matter, which are eaſily perceived through the delicate and tranſparent ſkin. The thigh-bone, for example, is then a ſmall ſhort tube,

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like the herbaceous tubes above defcribed. This tube is fhut at both ends by a pulpy fubftance, and its external and internal furfaces are covered with two membranes compofed of feveral layers of foft and ductile fibres. In proportion as this tube receives nutritious juices, the two extremities extend and recede from the middle point, which always preferves the fame ftation. The extremities cannot extend without reacting againft this middle point; and the parts which are neareft it begin firft to acquire folidity. The firft bony plate, like the firft plate of wood, is produced in the interval which feparates the two membranes or perioftea. But the offification commences in the middle, and gradually extends to the extremities, which remain foft long after the middle parts are converted into bone. The middle parts of bones, therefore, being firft offified, it is impoffible that they fhould afterwards expand equally with thofe parts which remain longer in a foft and ductile ftate. This is the reafon why bones are always thinneft in the middle, and thickeft at the extremities. But, independent of this difference between the longitudinal growth of bones and of wood, the analogy between their increafe in thicknefs is very ftriking: For the firft bony plate is produced from the internal part of the perioſteum; and, after the formation of this plate between the two perioftea, two other plates are foon formed, one on each fide of the firft,

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to which they adhere; and, by this means, both the circumference of the bone, and the diameter of its cavity, are augmented. Thus the interior parts of the two perioſtea continue ſucceſſively to produce bony plates, in the ſame manner as woody plates are produced from the bark of vegetables.

But, after the bone has acquired its full growth, after the perioſtea ceaſe to furniſh oſſeous matter, then the nutritious juices, which were formerly employed in augmenting the bulk of the bone, ſerve only to increaſe its denſity. Theſe juices are depoſited in the internal parts of the bones, and give them more weight and ſolidity, as may eaſily be perceived by comparing the weight and denſity of an ox with thoſe of a calf. The ſubſtance of the bones become, in proceſs of time, ſo compact, as not to admit the circulation of thoſe juices which are neceſſary for their ſupport and nouriſhment. This ſubſtance, therefore, muſt now undergo a change ſimilar to that which takes place in old trees, after they have acquired their full ſolidity; and this change is one of the firſt cauſes which render the diſſolution of the human body inevitable.

The cartilages, which may be regarded as ſoft and imperfect bones, likewiſe receive nutritious juices, which gradually augment their denſity. They become more and more ſolid as we advance in years; and, in old age, they are almoſt as hard as bones. This rigidity of the cartilages renders the motion of the joints extremely difficult, and, at laſt, deprives us of the uſe of our members, and produces a total ceſſation of external movements. This is a ſecond, and more marked cauſe of death, becauſe it manifeſts itſelf by a laborious performance of the common actions of the body.

The membranes likewiſe become hard and dry, as we advance in years. Thoſe, for example, which ſurround the bones, ſoon loſe their flexibility. At the age of 20, they are incapable of farther extenſion. The muſcular fibres ſuffer a ſimilar change, in proportion to the time of life; though, to the touch, they ſeem to be ſofter as age increaſes. It is not the muſcles, however, but the ſkin, that occaſions this perception. After the body is come to its full growth, the fat increaſes, and, by being interpoſed between the fibres of the muſcles, and between the ſkin and the muſcles themſelves, makes them feel ſofter, when, in reality, their denſity is greatly increaſed. Of this fact we have an inconteſtible proof, by comparing the fleſh of young with that of old animals. In the former, it is tender and delicate; but, in the latter, it is dry, hard, and unfit for eating.

The ſkin always extends as the body increaſes; but, when the body diminiſhes, the ſkin has not elaſticity enough to enable it to contract to its former dimenſions: It, therefore, continues in wrinkles and folds, which can never be effaced. The wrinkles of the face partly ariſe from this cauſe; but, in their production, they have a relation to the form, to the features, and to the habitual motions of the countenance. If we examine the face of a man of 25 or 30 years of age, we may trace the origin of all the wrinkles which will appear in old age, eſpecially when he laughs, cries, or makes any violent grimace. All the folds which are exhibited in theſe actions will in time become indelible wrinkles.

In proportion as we advance in years, the bones, the cartilages, the membranes, the fleſh, the ſkin, and every fibre of the body, become more ſolid, hard, and dry. Every part ſhrinks and contracts; and every movement is performed with ſlowneſs and difficulty: The circulation of the fluids is ſluggiſh and interrupted; perſpiration is diminiſhed; the ſecretions change; digeſtion becomes ſlow and laborious; the nutritious juices are leſs abundant, and, being rejected by parts which are already too denſe, they communicate no ſupplies. Theſe parts, therefore, may be regarded as already dead, becauſe they have ceaſed to receive nouriſhment. Thus the body dies by inches; its motions gradually decay; life wears away by imperceptible degrees; and death is only the laſt term in the ſeries.

As, in women, the bones, the cartilages, the muſcles, and every other part of the body, are ſofter

ſofter and leſs ſolid than thoſe of men, they muſt require more time in hardening to that degree which occaſions death: Women, of courſe, ought to live longer than men. This reaſoning is confirmed by experience; for, by conſulting the bills of mortality, it appears, that, after women have paſſed a certain age, they live much longer than men who have arrived at the ſame age.

From what has been ſaid, it may alſo be concluded, that men who have a weakly appearance, and approach nearer to the conſtitution of women, ſhould live longer than thoſe who are more robuſt; and likewiſe, that perſons of either ſex, who are long before they arrive at their full growth, ſhould outlive thoſe who advance more rapidly to that point; becauſe, in this caſe, the bones, cartilages, and fibres, are later in arriving at that degree of ſolidity which is neceſſary to their deſtruction.

This natural cauſe of death is common to all animals, and even to vegetables. An oak periſhes only becauſe the oldeſt parts of the wood, which are in the centre, become ſo hard and compact, that they can receive no further nouriſhment. The moiſture they contain being deprived of circulation, and not being replaced by freſh ſupplies, ferments, corrupts, and gradually reduces the fibres of the wood into powder.

The duration of life may, in ſome meaſure, be computed by the time occupied in growth. A plant or an animal that acquires maturity in

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a ſhort time, periſhes much ſooner than thoſe which are longer in arriving at that period. In animals, as well as vegetables, the longitudinal growth is firſt finiſhed. Man grows in ſtature till he be 16 or 18 years of age; but his body is not completely unfolded in thickneſs before that of 30. Dogs acquire their full length in leſs than one year; but their growth in thickneſs is not finiſhed till the ſecond year. A man, who grows 30 years, lives till 90 or 100; and a dog, whoſe growth terminates in two or three years, lives only 10 or 12. The ſame obſervation may be applied to moſt animals. Fiſhes continue to grow for a great number of years; they accordingly live for centuries; becauſe their bones never acquire the denſity of thoſe of other animals. When we give the particular hiſtory of animals, we ſhall examine whether there be any exception to this rule, which Nature ſeems to follow in proportioning the duration of life to the time of growth, and whether crows and ſtags live ſo long as is commonly imagined. But it may be laid down as a general fact, that large animals live much longer than ſmall animals, becauſe they require more time to finiſh their growth.

Thus the cauſes of our diſſolution are inevitable; and it is equally impoſſible to retard that fatal period, as to change the eſtabliſhed laws of Nature. The ideas of thoſe viſionaries, who conceived the poſſibility of perpetuating human life

life by the uſe of certain medicines, would have periſhed with themſelves, if ſelf-love did not always induce us to believe what exceeds the powers of Nature, and to be ſceptical with regard to the moſt certain and invariable truths. The univerſal panacea, the transfuſion of the blood, and other methods which have been propoſed to render our bodies immortal, are as chimerical as the fountain of youth is fabulous.

When the conſtitution is ſound, life may, perhaps, be prolonged for a few years, by moderating the paſſions, and by temperance. But even this is a difficult point; for, if it be neceſſary that the body ſhould exert its whole force, and that it ſhould waſte all its powers by labour and exerciſe, what advantages can we derive from regimen and abſtinence? Some men have indeed exceeded the ordinary term of human life: Without mentioning thoſe extraordinary inſtances of longevity recorded in the Philoſophical Tranſactions, ſuch as that of Par who lived to the age of 144, and of Jenkins who lived 165 years, we have many examples of the prolongation of life to 110, and even 120. Theſe men, however, uſed no peculiar arts for the preſervation of their bodies. They appear, on the contrary, to have been peaſants, huntſmen, labourers, and people accuſtomed to abuſe their bodies, if it be poſſible to abuſe them by any other means than thoſe of continual idleneſs and debauchery.

Besides, the varieties of climate, and of the modes of living, make no difference as to the period of our existence, which is the same in the European, the Negro, the Chinese, the American, the civilized man and the savage, the rich and the poor, the citizen and the peasant. Neither does the difference of races, of food, or of accommodation, make any change on the duration of life. Men who feed upon raw flesh or dried fish, on sago or rice, on cassada or roots, live as long as those who are nourished with bread and prepared victuals. It is apparent, therefore, that the duration of life has no dependence either on manners or customs, or the qualities of particular food: If luxury and intemperance be excepted, nothing can alter those laws of mechanism which regulate the number of our years.

Any little differences which may be remarked in the term of human life seem to be owing to the quality of the air. There are generally more old men in high than in low countries. The mountains of Scotland, of Wales, of Auvergne, and of Switzerland, have furnished more examples of extreme old age than the plains of Holland, Flanders, Germany, or Poland. But, taking mankind in general, there is hardly any difference in the duration of life. When men are not cut off by accidental diseases, they every where live 90 or 100 years. Our ancestors never exceeded this period; and, since

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the age of David, it has suffered no variation. If it should be asked, why the first races of men lived 900, 930, and even 969 years? we may, perhaps, be able to give a satisfactory answer. The productions of the earth were then of a different nature. The surface of the globe, as we remarked when treating of the Theory of the Earth, was, in the first ages of the world, less solid and compact; because, gravity having acted for a short time only, terrestrial bodies had not acquired their present density and consistence. The produce of the earth, therefore, must have been analogous to its condition. The surface being more loose and moist, its productions would, of course, be more ductile and capable of extension: Their growth, therefore, and even that of the human body, would require a longer time of being completed. The softness and ductility of the bones, muscles, &c. would probably remain for a longer period, because every species of food was more soft and succulent. Hence, the full expansion of the human body, or when it was capable of generating, must have required 120 or 130 years; and the duration of life would be in proportion to the time of growth, as is uniformly the case at present: For, if we suppose the age of puberty, among the first races of men, to have been 130 years, as they now arrive at that age in 14 years, the age of the Antedeluvians will be in exact proportion to that of the present race; since, by multiplying

multiplying these two numbers by seven, for example, the age of the present race will be 90, and that of the Antedeluvians will be 910. The period of man's existence, therefore, may have gradually diminished in proportion as the surface of the earth acquired more solidity by the constant action of gravity; and it is probable, that the period from the creation to the days of David, was sufficient to give the earth all the density it was capable of receiving from the influence of gravitation; and, consequently, that the surface of the earth has ever since remained in the same state, and that the terms of growth, in the productions of the earth, as well as in the duration of life, have been invariably fixed from that period.

Independent of accidental diseases, which are more frequent and dangerous in the latter periods of life, old men are subject to natural infirmities, that originate solely from the decay of the different parts of the body. The muscles lose their tone, the head shakes, the hands tremble, the legs totter, the sensibility of the nerves decreases, and every sense is blunted. But the incapacity for generating is the most characteristic infirmity of old age. This impotency may be ascribed to two causes; an alteration in the seminal fluid, and a want of tension in the external organs. The defect of tension is easily explained from the conformation of the organ itself, which is a spongy cavernous substance, fitted to receive into its cavities a great quantity of blood, in order both to increaſe its ſize, and to render it more rigid. In youth, this organ is ſoft and flexible; and, of courſe, it is eaſily extended by the impulſe of the blood. But, as we advance in years, like every other part of the body, it becomes more ſolid, and loſes its flexibility. Hence, though the impulſe of the blood were equal to what it was in youth, this impulſe is unable to dilate an organ which has become too denſe to admit blood in a quantity ſufficient to produce an erection that will anſwer the purpoſes of generation.

With regard to the change, or rather ſterility of the ſeminal fluid, it cannot be prolific unleſs when it contains organic particles tranſmitted from every part of the body; for we have already ſhown *, that the production of a ſmall organized being, ſimilar to its parent, cannot be effected without the union of the organic particles ſent from all parts of the body. But, in very aged men, the parts have become too ſolid, and can neither receive, aſſimilate, nor tranſmit the nutritive and prolific particles. The bones and other ſolids, therefore, can neither produce nor tranſmit organic particles correſpondent to their own natures; theſe particles muſt, of courſe, be wanting in the ſeminal fluids of old men; and this defect is ſufficient to render them incapable of generating.

But,

* See above, ch. 2. 3. &c.

But, admitting the ſterility of old men to be owing to a defect in the organic particles of their ſeminal fluids, this defect may ſtill be ſupplied by a young woman *, which not unfrequently happens; for old men ſometimes, though rarely, generate; and, when they do produce, they have a much ſmaller ſhare in their children than young men. This is likewiſe one reaſon why young women, who are married to old, decrepit, and deformed men, often produce monſters, or children ſtill more deformed than their fathers. But this is not a proper place for ſuch diſcuſſions.

The greateſt part of mankind die of the ſcurvy, the dropſy, or other diſeaſes which ſeem to proceed from a vitiation of the blood and other fluids. Whatever influence the fluids may have in the animal oeconomy, they are only paſſive and diviſible ſubſtances, and obey the impulſes of the ſolids, which are the true organic active parts, and upon which the motion, the quality, and even the quantity of the fluids entirely depend. In old age, the cavities of the veſſels contract, the muſcles loſe their tone, the ſecretory organs are obſtructed; the blood, the lymph, and the other fluids, of courſe, grow viſcid, extravaſate, and produce all thoſe diſeaſes and ſymptoms which are uſually aſcribed to a vitiation of the humours. But the natural decay of the ſolids is the original cauſe of theſe maladies.

 Though

* See above, ch. 10.

Though it be true, that the bad ſtate of the fluids proceeds from a depravity in the organization of the ſolids; yet the effects reſulting from a change in the fluids produce the moſt alarming ſymptoms, if they become ſtagnant, or if they be obſtructed in their circulation by the contraction of the veſſels; if, by the relaxation of the veſſels, they extravaſate, they muſt ſoon corrupt, and corrode the weaker parts of the ſolids. In this manner the cauſes of deſtruction perpetually multiply; our internal enemies grow more and more powerful, and at laſt put a period to our exiſtence.

All the cauſes of decay which I have mentioned, act continually upon the human body, and gradually lead to its diſſolution. Death, which appears ſo terrible to us, is the laſt term only in the ſeries of evils. Life begins to decay long before it is entirely extinguiſhed; and the changes are perhaps greater from youth till the beginning of our decay, than from decrepitude to death; for we ought here to conſider life as a ſubject capable of augmentation and of diminution. When the foetus is firſt formed, the quantity of life is almoſt equal to nothing: It gradually extends and acquires conſiſtence and force, in proportion to the growth and expanſion of the body. On the other hand, when the body begins to decay, the quantity of life diminiſhes, till its final extinction. Thus life both

both commences and terminates by imperceptible degrees.

Why then ſhould we be afraid of death, if we have no reaſonable apprehenſions of its conſequences? Why dread this ſingle moment, which has been preceded by an infinity of others of the ſame order; ſince death is fully as natural as life, and both arrive in the ſame manner, without our being able to perceive their approach? If we inquire of phyſicians, and thoſe who are accuſtomed to obſerve the actions and ſentiments of the dying, we ſhall find, that, except in a few acute diſeaſes, attended with agitations and convulſions, which exhibit only the appearances of pain, moſt men expire quietly, and without the ſmalleſt indication of unneaſineſs. Even when patients ſeem to be afflicted with the moſt dreadful agonies, they have no exiſtence but in the imagination of the ſpectator: The truth of this has been repeatedly atteſted by many people who have recovered after the moſt violent commotions and convulſions, who, notwithſtanding, were unable to recollect a ſingle pang they had felt, or a ſingle idea or ſentiment that had paſſed during this ſeemingly diſtreſsful ſituation.

The greateſt part of mankind, therefore, die without being ſenſible of the fatal ſtroke; and of thoſe who preſerve their ſenſes to the laſt groan, there is not, perhaps, one who does not entertain ſome hope of recovery. Nature, for the happineſs of man, has rendered this principle

ple much ſtronger than reaſon. Men never ceaſe to flatter themſelves with hopes of recovery, even though they might judge of their real condition from the example of others who had been afflicted with the ſame incurable diſorders, from the tears of their friends, and from the countenances or deſertion of their phyſicians. All theſe mortifying circumſtances are only regarded as premature and ill-grounded fears; and hope never leaves us, till death ſhuts the ſcene.

A ſick man tells you, that he feels the hand of death, that the king of terrors is juſt about to arrive, and that recovery is impoſſible: But if, from zeal or indiſcretion, he is informed of his approaching diſſolution, his countenance inſtantly changes, and he betrays all that uneaſineſs which naturally attends the firſt intimation of death. This man, it is evident, gives no credit to his own aſſertions. He may entertain ſome doubts concerning his ſituation; but his hopes are always ſuperior to his fears: And, if he were not alarmed by that cruel parade of grief which too often imbitters the ſick man's couch, he would never perceive the approach of his diſſolution.

Death, therefore, is not that horrible object which we have fancied to ourſelves. It is a ſpectre which terrifies us at a diſtance, but diſappears when we approach it more cloſely. Our conceptions of it are founded on prejudice; and we regard it not only as the greateſt of all miſfortunes,

fortunes, but as accompanied with the moſt excruciating tortures. The pain, it is ſaid, muſt be extreme when the ſoul ſeparates from the body; its duration may alſo be long, ſince time is meaſured by the celerity of ideas; and one painful moment, by augmenting the rapidity of our ideas, may have the appearance of an age, when the train of ideas proceeds with their uſual gentleneſs aud tranquillity. This reaſoning is ſuch an abuſe of philoſophy, that, if it had no influence in increaſing the miſeries of human life, it merits nothing but ſilence and contempt. As ſuch arguments, however, gain credit with weak minds, and render the aſpect of death a thouſand times more hideous than it really is, a refutation of them may be attended with utility.

When the ſoul is firſt united to the body, do we feel a joy that tranſports us? No. This union is effected without our perception; why, then ſhould we be conſcious of their diſſolution? What reaſon have we to believe that the ſeparation of the ſoul and body is attended with extreme pain? What cauſe ſhould produce this pain? Does it reſide in the ſoul or in the body? Pain of mind can only reſult from thought; and pain of body is always proportioned to its ſtrength or weakneſs. At the approach of natural death, the body is in its weakeſt ſtate, and, of courſe, it can feel but very little, if any pain.

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Let us now ſuppoſe a violent death: Can the ſufferings of a man, for example, whoſe head is carried off by a cannon-ball, be more than inſtantaneous; Can the ſucceſſion of his ideas, during this inſtant, be ſo rapid as to make the pain ſeem to continue for an hour, a day, or a century? We ſhall endeavour to diſcuſs this point.

I acknowledge that the ſucceſſion of our ideas is the only natural meaſure of time, and that we conceive it to be ſhorter or longer in proportion to the uniformity or irregularity of their motions. But, in this meaſure, there is a unit or fixed point, which is neither arbitrary nor indefinite, but is determined by Nature, and correſponds with the particular organization of individuals. Two ideas, which ſucceed each other, muſt neceſſarily be ſeparated by an interval; one thought, however rapid, muſt require ſome portion of time before it can be followed by another. No ſucceſſion can take place in an indiviſible inſtant. The ſame remark is applicable to ſentiment or feeling. A certain time muſt elapſe in the tranſition from pain to pleaſure, or from one painful ſenſation to another. This interval between our thoughts and ſenſations is the unit or fixed point formerly mentioned; and it can neither be extremely long nor extremely ſhort, but muſt be nearly equal in its duration; becauſe it depends on the nature of the mind and the organization of the body, the movements of which muſt have a determined degree of celerity. In the ſame indi-

vidual,

vidual, therefore, there can be no ſucceſſion of ideas ſo rapid, or ſo ſlow, as to produce that enormous difference in duration, by which a momentary pain is prolonged to that of an hour, a day, or a century.

A very acute pain, if continued for a certain time, uniformly brings on either fainting or death. Our organs, which are endowed only with a certain degree of force, cannot reſiſt more than a certain quantity of pain. If the pain becomes exceſſive, the organs are unable to ſupport it; and, of courſe, they can tranſmit no intelligence of it to the mind, with which there is no correſpondence but by the diſtinct action of theſe organs. In this caſe, the action of the organs is interrupted; and, conſequently, all internal ſenſation is at an end.

What I have already remarked is perhaps more than is ſufficient to evince, that the inſtant of death is neither accompanied with extreme nor long-continued pain. But, in order to eradicate the fears of the moſt timid of mankind, we ſhall ſtill add a few words upon this ſubject. Exceſſive pain extinguiſhes all reflection, though ſymptoms of it have ſometimes appeared in the very moment of violent death. When Charles XII. received the blow which terminated, in an inſtant, both his enterpriſes and his exiſtence, he clapped his hand upon his ſword. This mortal pang, ſince it excluded not reflection, could not be exceſſive. He found himſelf attacked; he he considered that he ought to defend himself; it is evident, therefore, that he felt no greater pain than he would have suffered from an ordinary stroke. This action could not be the result of a mechanical impulse; for I have shewn, in the description of man, that the most precipitate movements of the passions depend upon reflection, and are nothing but habitual exertions of the mind.

I would not have dwelt so long upon this subject, if I had not been anxious to eradicate a prejudice so repugnant to the happiness of man. I have seen many victims sacrificed to this prejudice, especially among the female sex, who die daily through the terror of death. Such dreadful apprehensions seem peculiarly to affect those who, by nature or education, are endowed with superior sensibility; for the vulgar look forward to their dissolution, either with indifference, or, at least, without any degree of terror.

True philosophy views objects as they exist. Our internal feelings would uniformly accord with this philosophy, if they were not perverted by the illusions of imagination, and by the unfortunate habit of creating hypothetical phantoms of excessive pains, and of pleasures which exceed the limits of human nature. Objects are only terrible or ravishing at a distance; when we have the resolution or the wisdom to take a near inspection of them, every alarming and every alluring circumſtance inſtantly diſappear.

If this doctrine, concerning the gradual and generally inſenſible decay of the vital powers, required any farther ſupport, no inconſiderable aid might be derived to it from the uncertainty of the ſigns of death. If we conſult the writers on this ſubject, and particularly thoſe of Winſlow and Bruhier, we ſhall receive full conviction, that, between life and death, the ſhade is often ſo undiſtinguiſhable, as to elude all the powers of the medical art. They inform us, 'That the colour of the face, the heat of the body, the ſuppleneſs of the joints, are uncertain marks of 'life; and that the paleneſs of the countenance, 'the coldneſs of the body, the rigidity of the 'extremities, the ceſſation of motion, and the 'abolition of the ſenſes, are very equivocal ſigns 'of death.' The ſame remark may be made with regard to the apparent ceſſation of the pulſe, and of reſpiration: Theſe motions are often ſo ſlow, that they elude all our perceptions. A mirror or a candle is applied near the mouth of a ſick man; if the mirror be ſullied, or the flame vibrates, life is concluded not to be extinguiſhed. But theſe effects are often produced, after death has actually taken place; and ſometimes they appear not, though the patient be ſtill alive. When we wiſh to be certain of the death of any perſon, we apply fumes of tobacco, and other irritating bodies, to the noſtrils; we endeavour

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to excite the organs by violent agitations, by pricking or ſcarifying the hands and feet, by applying red hot iron or wax to different parts of the body, by raiſing loud and unuſual cries, &c. But inſtances have occurred where all theſe and ſimilar trials have proved abortive; and yet, to the aſtoniſhment of the ſpectators, the perſon ſuppoſed to be dead has afterwards recovered the powers of life.

Hence nothing can be more apparent, than that a certain condition of life has a great reſemblance to actual death. Both humanity and reaſon, therefore, require that we ſhould be cautious of abandoning the body, and of committing it too haſtily to the grave. Neither ten, twenty, nor twenty-four hours are ſufficient to diſtinguiſh a real from an apparent death; ſince inſtances are not wanting of perſons returning from the tomb at the end of two and of three days. Why ſhould we precipitate the interment of thoſe perſons, the prolongation of whoſe lives we moſt ardently deſire? Why ſhould a practice ſubſiſt, in the abolition of which all men are equally intereſted? Are not the frequent abuſes recorded by phyſicians ſufficient to deter us from too haſty interments? Mr Winſlow * informs us, 'That the body, though living, is 'ſometimes ſo completely deprived of every vi'tal function, that it has every external appear'ance

* See Winſlow diſſert. ſur l'incertitude des ſignes de la mort, p. 84.

'ance of death. But,' he remarks, 'both religion and charity require, that a reaſonable 'time ſhould be allowed to diſcover whether any 'ſigns of life may not ſtill manifeſt themſelves, 'otherwiſe we become actual murderers, by 'burying people who are not dead. If we may 'credit the greateſt number of authors, three 'days, or 72 hours, are ſufficient for this purpoſe. If, during this period, no ſigns of life 'appear, but, on the contrary, the body begins 'to emit a cadaverous odour, which is an infallible mark of death, we may then bury it without ſcruple.'

We ſhall afterwards have an opportunity of mentioning the cuſtoms of different nations with regard to funerals, embalming, &c. The greateſt part, even of the moſt ſavage people, pay more attention than we to their departed friends: What we eſteem a ceremony only, they regard as a primary duty: They reſpect their dead; they clothe them; they ſpeak to them; they recite their exploits; they praiſe their virtues: But we, who pretend to ſuperior ſenſibility, fly from our dead, and inhumanly abandon them; we deſire not to ſee them; we have neither the courage nor the inclination to ſpeak of them; we even avoid ſuch objects or ſituations as might recal the idea of them: We are, therefore, either more indifferent, or weaker than ſavages.

Having

Having thus traced the hiſtory of life and death with regard to the individual, let us now conſider both in relation to the whole ſpecies. Man dies at every age; and, though the duration of his life be longer than that of moſt animals, yet it is unqueſtionably more various and uncertain. Attempts have lately been made to aſcertain theſe uncertainties, and, by obſervations, to fix ſome ſtandard with regard to the mortality of mankind at different periods of life. If theſe obſervations were ſufficiently numerous and exact, they would be of great utility in determining the number of people, their increaſe, the conſumption of proviſions, &c. Many authors have written with ability on this ſubject. M. de Parcieux, of the academy of ſciences, has lately publiſhed an excellent work for regulating tontins and annuities. But, as his principal object was to calculate the mortality of annuitants, and as ſuch perſons are particularly pitched upon for their apparent ſtrength of conſtitution, his calculations cannot be applied to mankind in general. For the ſame reaſon, his curious tables of the mortality of the different orders of religious muſt be confined to their proper objects. Hally, Grant, Kerſboom, Simpſon, &c. have alſo given tables of the mortality of the human ſpecies. But, as their obſervations have been limited to the bills of mortality in a few pariſhes of London, Breſlau, and other large towns, they can afford little information as to the general mortality

mortality of mankind. To make complete tables of this kind, it is neceſſary to ſcrutinize the pariſh-regiſters, not only of London, Paris, &c. where there is a perpetual ingreſs of ſtrangers, and egreſs of natives, but likewiſe thoſe of the country, that, by comparing the reſults of both, general concluſions may be formed. M. Dupré de St Maur, a member of the French Academy, has executed this plan upon twelve pariſhes in the country of France, and three in Paris. Having obtained his permiſſion to publiſh his tables, I do it the more chearfully, as they are the only calculations by which the probability of human life, in general, can be aſcertained with any degree of certainty.

YEARS of LIFE.

Parishes.	Deaths.	1	2	3	4	5
Clemont - -	1391	578	73	36	29	16
Brinon - -	1141	441	75	31	27	10
Jouy - -	588	231	43	11	13	5
Leſtiou - -	223	89	16	9	7	1
Vandeuvre -	672	156	58	18	19	10
St. Agil - -	954	359	64	30	21	20
Thury - -	262	103	31	8	4	3
St. Amant -	748	170	61	24	11	12
Montigny - -	833	346	57	19	25	16
Villeneuve -	131	14	3	5	1	1
Gouſſainville -	1615	565	184	63	38	34
Ivry - -	2247	686	298	96	61	50
Total deaths	10805					
Diviſion of 10805 deaths into the years they happened.		3738	963	350	256	178
Deaths before the end of 1ſt, 2d, &c. years.		3738	4701	5051	5307	5485
Number of perſons entered into their 1ſt, 2d, &c. years.		10805	7067	6104	5754	5498
St. André -	1728	201	122	94	82	50
St. Hippolyte	2516	754	361	127	64	60
St. Nicolas -	8945	1761	932	414	298	221
Total deaths	13189					
Diviſion of 13189 deaths into the years they happened.		2716	1415	635	444	331
Deaths before the end of 1ſt, 2d, &c. years.		2716	4131	4766	5210	5541
Number of perſons entered into their 1ſt, 2d, &c. years.		13189	10473	9058	8423	7979
Diviſion of 23994 deaths in the three pariſhes of Paris, and 12 country pariſhes.		6454	2378	985	700	509
Deaths before the end of 1ſt, 2d, &c. years.		6454	8832	9817	10517	11026
Number of perſons entered into their 1ſt, 2d, &c. years.		23994	17540	15162	14177	12477

YEARS of LIFE.

6	7	8	9	10	11	12	13
16	14	10	8	4	6	5	6
16	9	9	8	5	2	12	2
8	4	6	1	0	3	0	3
4	3	1	1	1	0	1	0
11	8	10	3	2	1	3	3
11	4	7	2	7	3	3	3
2	2	2	1	2	0	0	0
15	3	6	8	6	4	4	2
21	9	7	5	5	2	4	4
0	0	0	0	0	0	1	0
21	17	15	12	8	5	5	9
29	34	26	13	19	9	6	4
154	107	99	62	59	35	44	36
5639	5746	5845	5907	5960	6001	6045	6081
5320	5166	5059	4960	4898	4839	4804	4760
35	28	14	8	7	3	9	6
55	25	16	20	8	9	9	6
162	147	111	64	40	34	38	25
252	200	141	92	55	46	56	37
5793	5993	6134	6226	6281	6327	6383	6420
7648	7396	7196	7055	6963	6908	6862	6806
406	307	240	154	114	81	100	73
11432	11639	11979	12133	12247	12328	12428	12501
12968	12562	12255	12015	11861	11747	11666	11566

		YEARS of LIFE.				
Parishes.	Deaths.	14	15	16	17	18
Clemont - -	1391	5	5	6	6	10
Brinon - -	1141	6	4	5	9	4
Jouy - -	588	3	1	6	4	4
Leſtiou - -	223	1	1	1	1	0
Vandeuvre -	672	4	5	6	3	3
St. Agil - -	954	3	5	2	7	8
Thury - -	262	0	1	0	1	1
St. Amant -	748	5	1	5	3	6
Montigny - -	833	2	4	2	2	3
Villeneuve -	131	0	1	0	2	4
Gouſſainville -	1615	5	5	2	5	10
Ivry - -	2247	4	8	7	4	14
Total deaths	10805					
Diviſion of 10805 deaths into the years they happened.		38	41	42	47	67
Deaths before the end of 14th, 15th, &c. years.		6119	6160	6202	6249	6316
Number of perſons entered into their 14th, 15th, &c. years.		4724	4686	4645	4603	4556
St. André -	1728	7	10	13	13	11
St. Hippolyte	2516	7	6	5	7	9
St. Nicolas -	8945	21	33	37	37	28
Total deaths	13189					
Diviſion of 13189 deaths into the years they happened.		35	49	55	57	48
Deaths before the end of 14th, 15th, &c. years.		6455	6504	6559	6616	6664
Number of perſons entered into their 14th, 15th, &c. years.		6769	6734	6685	6630	6573
Diviſion of 23994 deaths in the three pariſhes of Paris, and 12 country pariſhes.		73	90	97	104	115
Deaths before the end of 14th, 15th, &c. years.		12574	12664	12761	12865	12980
Number of perſons entered into their 14th, 15th, &c. years.		11493	11420	11330	11233	11129

YEARS of LIFE.

19	20	21	22	23	24	25	26
3	13	8	9	10	7	22	9
5	14	8	14	7	11	24	9
3	5	2	4	4	4	5	2
0	0	0	0	3	0	1	1
4	7	4	6	8	6	22	3
5	6	4	6	3	6	11	10
1	1	1	3	1	1	2	2
1	4	7	6	6	4	5	4
3	5	4	3	10	8	7	3
0	1	1	4	1	0	1	0
9	10	6	10	5	6	11	9
10	12	6	15	10	9	10	14
44	78	51	80	68	62	121	66
6360	6438	6480	6569	6637	6699	6820	6886
4489	4445	4367	4316	4236	4168	4106	3985
10	7	9	17	11	9	9	8
7	3	2	8	7	9	10	13
44	53	31	56	48	41	59	47
61	63	42	81	66	59	78	68
6725	6788	6830	6911	6977	7036	7114	7182
6525	6464	6401	6359	6278	6212	6153	6075
105	141	93	161	134	121	199	134
13085	13226	13319	13480	13614	13735	13934	14068
11014	10909	10768	10675	10514	10380	10259	10060

Parishes.	Deaths.	27	28	29	30	31
		YEARS of LIFE.				
Clemont - -	1391	13	10	7	24	4
Brinon - -	1141	7	13	6	28	6
Jouy - -	588	2	3	4	8	2
Leſtiou - -	223	1	3	1	1	4
Vandeuvre -	672	5	10	1	28	2
St. Agil - -	954	4	9	2	16	8
Thury - -	262	0	5	2	2	0
St. Amant -	748	4	3	3	8	2
Montigny -	833	3	3	0	6	1
Villeneuve -	131	2	1	1	2	1
Gouſſainville	1615	9	8	10	10	4
Ivry - -	2247	5	9	5	13	8
Total deaths	10805					
Diviſion of 10805 deaths into the years they happened.		55	77	42	146	42
Deaths before the end of 27th, 28th, &c. years.		6941	7018	7060	7206	7248
Number of perſons entered into their 27th, 28th, &c. years.		3919	3864	3787	3745	3599
St. André -	1728	17	13	11	21	6
St. Hippolyte	2516	10	10	9	7	9
St. Nicolas -	8945	53	51	34	63	25
Total deaths	13189					
Diviſion of 13189 deaths into the years they happened.		80	74	54	91	40
Deaths before the end of 27th, 28th, &c. years.		7262	7336	7390	7481	7521
Number of perſons entered into their 27th, 28th, &c. years.		6007	5927	5853	5799	5708
Diviſion of 23994 deaths in the three pariſhes of Paris, and 12 country pariſhes.		135	151	96	237	82
Deaths before the end of 27th, 28th, &c. years.		14203	14354	14450	14687	14769
Number of perſons entered into their 27th, 28th, &c. years.		9926	9793	9640	9544	9307

YEARS of LIFE.

32	33	34	35	36	37	38	39
13	14	8	17	12	18	15	3
15	3	4	20	8	8	8	6
5	4	3	13	6	7	4	1
4	3	1	6	4	4	1	1
9	1	3	17	5	5	4	0
7	2	5	18	9	4	5	1
3	1	0	7	0	1	2	2
8	6	5	7	4	5	5	3
10	3	4	8	4	1	2	0
2	1	0	6	5	0	5	0
14	6	7	8	8	5	2	7
11	18	10	19	12	13	23	3
101	62	50	146	77	71	76	27
7349	7411	7461	7607	7684	7755	7831	7858
3557	3456	3394	3344	3198	3121	3050	2974
10	17	15	21	14	8	12	4
12	13	13	16	21	15	13	10
57	41	54	82	75	58	59	46
79	71	82	119	110	81	84	60
7600	7671	7753	7872	7982	8063	8147	8207
5668	5589	5518	5436	5317	5207	5126	5042
180	133	132	265	187	158	160	87
14949	15082	15214	15479	15666	15818	15978	16065
9245	9045	8912	8770	8515	8328	8176	8016

Parishes.	Deaths.	40	41	42	43	44
		YEARS of LIFE.				
Clemont -	1391	41	4	10	10	6
Brinon -	1141	37	6	8	3	6
Jouy - -	588	20	0	3	0	4
Leſtiou - -	223	4	0	2	2	0
Vandeuvre -	672	41	1	3	2	2
St. Agil -	954	22	2	8	7	3
Thury - -	262	4	1	3	1	4
St Amant -	748	20	1	6	2	4
Montigny -	833	8	3	6	5	4
Villeneuve -	131	7	0	3	1	0
Gouſſainville -	1615	14	10	11	4	5
Ivry - -	2247	27	7	19	7	14
Total deaths	10805					
Diviſion of 10805 deaths into the years they happened		245	35	82	44	52
Deaths before the end of 40th, 41ſt, &c. years		8103	8138	8220	8264	8316
Number of perſons entered into their 40th, 41ſt, &c. years.		2947	2702	2667	2585	2541
St André -	1728	26	5	19	12	10
St. Hippolyte -	2516	24	4	18	14	9
St. Nicolas -	8945	109	37	73	58	45
Total deaths	13189					
Diviſion of 13189 deaths into the years they happened		159	46	110	84	64
Deaths before the end of 40th, 41ſt, &c. years.		8366	8412	8522	8606	8670
Number of perſons entered into their 40th, 41ſt, &c. years.		4982	4823	4777	4667	4583
Diviſion of 23994 deaths in the three pariſhes of Paris, and 12 country pariſhes.		404	81	192	128	116
Deaths before the end of 40th, 41ſt, &c. years.		16469	16550	16742	16870	16986
Number of perſons entered into their 40th, 41ſt, &c. years.		7929	7525	7444	7252	7124

YEARS of LIFE.

45	46	47	48	49	50	51	52
20	5	8	5	6	31	0	5
11	5	6	9	0	23	1	3
13	3	4	2	0	20	2	3
3	3	0	3	3	5	1	1
14	5	3	1	0	31	0	2
14	1	3	3	0	24	3	9
3	0	0	0	0	3	0	0
13	3	4	6	0	23	1	4
13	6	1	6	1	10	2	5
2	1	2	3	0	7	2	1
11	9	5	12	6	15	4	9
22	10	7	12	6	24	6	14
139	51	43	62	22	216	22	56
8455	8506	8549	8611	8633	8849	8871	8927
2489	2350	2299	2256	2194	2172	1956	1934
24	21	9	13	10	24	7	18
33	14	13	15	12	20	10	19
111	54	47	68	50	120	40	59
168	89	69	96	72	164	57	96
8838	8927	8996	9092	9164	9328	9385	9481
4519	4351	4262	4193	4097	4025	3861	3804
307	140	112	158	94	380	79	152
17293	17433	17545	17703	17797	18177	18256	18408
7008	6701	6561	6449	6291	6167	5817	5738

		YEARS of LIFE.				
PARISHES.	Deaths.	53	54	55	56	57
Clemont - -	1391	5	5	14	5	5
Brinon -	1141	3	2	10	6	2
Jouy - -	588	2	5	7	4	5
Leftiou - -	223	0	0	2	2	0
Vandeuvre -	672	1	1	13	1	1
St. Agil -	954	2	2	10	3	5
Thury - -	262	1	1	4	0	1
St Amant -	748	4	4	6	5	4
Montigny -	833	2	5	10	3	4
Villeneuve -	131	0	1	0	3	1
Gouffainville -	1615	5	9	6	10	10
Ivry - -	2247	13	9	29	12	13
Total deaths	10805					
Divifion of 10805 deaths into the years they happened.		38	44	111	54	51
Deaths before the end of 53d, 54th, &c. years.		8965	9009	9120	9174	9225
Number of perfons entered into their 53d, 54th, &c. years.		1878	1840	1796	1685	1631
St André -	1728	8	10	19	11	15
St. Hippolyte -	2516	6	10	25	9	15
St. Nicolas -	8945	49	46	125	56	48
Total deaths	13189					
Divifion of 13189 deaths into the years they happened		63	66	169	76	78
Deaths before the end of 53d, 54th, &c. years.		9544	9610	9779	9855	9933
Number of perfons entered into their 53d, 54th, &c. years.		3708	3645	3579	3410	3334
Divifion of 23994 deaths in the three parifhes of Paris, and 12 country parifhes.		101	110	280	130	129
Deaths before the end of 53d, 54th, &c. years.		18509	18619	18899	19029	19158
Number of perfons entered into their 53d, 54th, &c. years.		5586	5485	5375	5095	4965

YEARS of LIFE.

58	59	60	61	62	63	64	65
4	4	52	2	6	5	2	5
3	0	24	1	3	4	7	7
2	0	20	0	5	2	4	5
3	0	2	0	0	1	0	3
2	0	35	0	0	1	1	5
3	3	22	3	2	7	5	7
3	1	6	0	3	2	2	2
7	2	27	0	4	3	4	12
9	2	13	3	7	5	5	7
2	1	4	3	0	1	1	2
10	3	24	6	9	7	6	13
13	3	40	3	12	12	11	14
61	19	269	21	51	50	48	82
9286	9305	9574	9595	9646	9696	9744	9826
1580	1519	1500	1231	1210	1159	1109	1061
17	11	46	11	21	19	17	20
18	12	35	7	28	21	23	25
86	48	184	42	77	71	73	95
121	71	265	60	126	111	113	140
10054	10125	10390	10450	10576	10687	10800	10940
3256	3135	3064	2799	2739	2613	2502	2389
182	90	534	81	177	161	161	122
19340	19430	19964	20045	20222	20383	20544	20766
4836	4654	4564	4030	3949	3772	3611	3450

Parishes.	Deaths.	66	67	68	69	70
Clemont - -	1391	5	3	4	1	11
Brinon - -	1141	6	3	6	0	6
Jouy - -	588	2	1	1	1	3
Leſtiou - -	223	1	1	0	1	0
Vandeuvre -	672	3	0	2	1	9
St. Agil - -	954	3	6	5	2	19
Thury - -	262	1	3	1	0	7
St. Amant -	748	7	5	6	6	18
Montigny -	833	6	2	5	1	9
Villeneuve -	131	3	0	1	0	4
Gouſſainville	1615	17	13	15	5	16
Ivry - -	2247	21	5	23	7	31
Total deaths	10805					
Diviſion of 10805 deaths into the years they happened.		75	42	69	25	133
Deaths before the end of 66th, 67th, &c. years.		9901	9943	10012	10037	10170
Number of perſons entered into their 66th, 67th, &c. years.		979	904	862	793	768
St. André -	1728	27	21	25	9	36
St. Hippolyte	2516	19	12	20	13	35
St. Nicolas -	8945	95	67	115	50	177
Total deaths	13189					
Diviſion of 13189 deaths into the years they happened.		141	100	160	72	248
Deaths before the end of 66th, 67th, &c. years.		11081	11181	11341	11413	11661
Number of perſons entered into their 66th, 67th, &c. years.		2249	2108	2008	1848	1776
Diviſion of 23994 deaths in the three pariſhes of Paris, and 12 country pariſhes.		216	142	229	97	382
Deaths before the end of 66th, 67th, &c. years.		20982	21124	21353	21450	21831
Number of perſons entered into their 66th, 67th, &c. years.		3228	3012	2870	2641	2544

Years of life: 66–70.

YEARS of LIFE.

71	72	73	74	75	76	77	78
1	3	1	3	5	1	1	2
2	12	2	0	4	2	0	3
1	2	0	1	1	0	0	0
0	2	0	0	0	0	0	0
1	4	0	0	3	0	1	0
1	11	5	5	8	0	3	4
0	2	1	0	0	0	1	0
3	10	2	2	18	2	4	4
2	8	3	2	9	1	4	2
0	3	0	0	0	0	2	1
8	22	12	12	16	6	6	8
6	21	11	19	24	12	11	14
25	100	37	44	88	24	33	38
10195	10295	10332	10376	10464	10488	10521	10559
635	610	510	473	429	341	317	284
9	25	14	19	20	16	10	25
10	28	5	15	23	11	18	15
64	118	53	90	127	63	59	69
83	171	72	124	170	90	87	109
11744	11915	11987	12111	12281	12371	12458	12567
1528	1445	1274	1202	1078	908	818	731
108	271	109	168	258	114	120	147
21939	22210	22319	22487	22745	22859	22979	23126
2160	2155	1784	1675	1507	1249	1135	1015

		YEARS of LIFE.				
PARISHES.	Deaths.	79	80	81	82	83
Clemont -	1391	2	6	0	0	0
Brinon - -	1141	0	3	1		
Jouy - -	588	0	2	0	0	0
Leftiou - -	223	0	1	0	0	0
Vandeuvre -	672	0	7	0	0	0
St. Agil -	954	0	6	0	0	0
Thury - -	262	0	3			
St. Amant -	748	2	17	1	3	1
Montigny -	833	0	5	1	4	1
Villeneuve -	131	1	1	0	0	0
Gouffainville -	1615	1	17	6	9	5
Ivry - -	2247	9	19	7	14	4
Total deaths	10805					
Divifion of 10805 deaths into the years they happened.		15	89	16	30	11
Deaths before the end of 79th, 80th, &c. years.		10574	10663	10679	10709	10720
Number of perfons entered into their 79th, 80th, &c. years.		246	231	142	126	96
St. André -	1728	8	17	4	10	8
St. Hippolyte -	2516	8	18	4	5	16
St. Nicolas -	8945	30	121	32	41	37
Total deaths	13189					
Divifion of 13189 deaths into the years they happened.		46	156	40	56	61
Deaths before the end of 79th, 80th, &c. years.		12613	12769	12809	12865	12926
Number of perfons entered into their 79th, 80th, &c. years.		622	576	420	380	324
Divifion of 23994 deaths in the three parifhes of Paris, and 12 country parifhes.		61	245	56	86	72
Deaths before the end of 79th, 80th, &c. years.		23187	23432	23488	23574	23646
Number of perfons entered into their 79th, 80th, &c. years.		868	807	562	506	420

YEARS of LIFE.

84	85	86	87	88	89	90	91
3	0	1	0	0	1		
0	0	0	0	1			
0	1						
0	0	0	1	1			
0	0	0	0	0	0	2	0
3	4	0	1	2	0	4	1
1	0	0	0	0	0	1	
0	0	0	0	0	1		
7	2	4	4	2	2		
7	5	4	2	3	1	2	0
21	12	9	8	9	5	9	1
10741	10753	10762	10770	10779	10784	10793	10794
85	64	52	43	35	26	21	12
7	3	7	4	5	2	4	0
4	10	4	1	4	2	2	2
25	35	19	20	25	4	17	5
36	48	30	25	34	8	23	7
12962	13010	13040	13065	13099	13107	13130	13137
263	227	179	149	124	90	82	59
57	50	39	33	43	13	32	8
23703	23763	23802	23835	22878	23891	23923	23931
348	291	231	192	159	116	103	71

		YEARS of LIFE.				
PARISHES.	Deaths.	92	93	94	95	96
Clemont -	1391					
Brinon - -	1141					
Jouy - -	588					
Leftiou - -	223					
Vandeuvre -	672					
St. Agil -	954	0	0	0	0	0
Thury - -	262					
St. Amant -	748	1	0	0	2	1
Montigny -	833					
Villeneuve -	131					
Gouffainville -	1615					
Ivry - -	2247	2	0	0	1	0
Total deaths	10805					
Divifion of 10805 deaths into the years they happened.		3	0	0	3	1
Deaths before the end of 92d, 93d, &c. years.		10797	10797	10797	10800	10801
Number of perfons entered into their 92d, 93d, &c. years.		11	8	8	8	5
St. André -	1728	2	1	2	0	1
St. Hippolyte -	2516	2	1	1	2	1
St. Nicolas -	8945	9	5	4	5	2
Total deaths	13189					
Divifion of 13189 deaths into the years they happened.		13	7	7	7	4
Deaths before the end of 92d, 93d, &c. years.		13150	13157	13164	13171	13175
Number of perfons entered into their 92d, 93d, &c. years.		52	39	32	25	18
Divifion of 23994 deaths in the three parifhes of Paris, and 12 country parifhes		16	7	7	10	5
Deaths before the end of 92d, 93d, &c. years.		23947	23954	23961	23971	23976
Number of perfons entered into their 92d, 93d, &c. years.		63	47	41	33	23

Parishes.	Deaths.	YEARS of LIFE. 97	98	99	100
Clemont	1391				
Brinon	1141				
Jouy	588				
Lestiou	223				
Vandeuvre	672				
St. Agil	954	0	0	0	1
Thury	262				
St. Amant	748	0	3		
Montigny	833				
Villeneuve	131				
Goussainville	1615				
Ivry	2247				
Total deaths	10805				
Division of 10805 deaths into the years they happened.		0	3	0	1
Deaths before the end of 97th, 98th, &c. years.		10801	10804	10804	10805
Number of persons entered into their 97th, 98th, &c. years.		4	4	1	1
St. André	1728	1	0	0	0
St. Hippolyte	2516	0	1		
St. Nicolas	8945	1	4	1	4
Total deaths	13189				
Division of 13189 deaths into the years they happened.		2	5	1	4
Deaths before the end of 97th, 98th, &c. years.		13177	13182	13183	13187
Number of persons entered into their 97th, 98th, &c. years.		14	12	7	6
Division of 23994 deaths in the three parishes of Paris, and 12 country parishes.		2	8	1	5
Deaths before the end of 97th, 98th, &c. years.		23978	23986	23987	23992
Number of persons entered into their 97th, 98th, &c. years.		18	16	8	7

Many uſeful concluſions might be drawn from the above tables of M. Dupré. But I ſhall confine myſelf to thoſe which regard the probabilities of the duration of life. In the columns under the years, 10, 20, 30, 40, 50, 60, 70, 80, and other round numbers, as 25, 35, &c. there are, in the country-pariſhes, more deaths than in the preceding or ſubſequent columns. This is owing to the ages not being juſtly regiſtered, moſt country-people being unable to aſcertain their ages within leſs than two or three years. If they die at 58 or 59, they are regiſtered at 60, and ſo of other round numbers. But this irregularity gives riſe to no great inconvenience, as it can eaſily be corrected by the manner in which the numbers ſucceed each other in the tables.

It appears from the tables of the country-pariſhes, that one half of the children die nearly about the end of the fourth year; but, from the Paris table, 16 years are neceſſary to produce the ſame effect. This great difference proceeds from a general practice of the Pariſians, who ſend their children to be nurſed in the country, which neceſſarily increaſes the number of deaths during the firſt years of infancy. In the following calculation, I have eſtimated the probabilities of the duration of life from a combination of both tables; which muſt, therefore, make a very near approach to the truth.

TABLE,

TABLE, ſhowing the probabilities of the duration of human life.

Age.	Duration of life.		Age.	Duration of life.		Age.	Duration of life.	
Years.	Years.	Months.	Years.	Years.	Months.	Years.	Years.	Months.
0	8	0	29	28	6	58	12	3
1	33	0	30	28	0	59	11	8
2	38	0	31	27	6	60	11	1
3	40	0	32	26	11	61	10	6
4	41	0	33	26	3	62	10	0
5	41	6	34	25	7	63	9	6
6	42	0	35	25	0	64	9	0
7	42	3	36	24	5	65	8	6
8	41	6	37	23	10	66	8	0
9	40	10	38	23	3	67	7	6
10	40	2	39	22	8	68	7	0
11	39	6	40	22	1	69	6	7
12	38	9	41	21	6	70	6	2
13	38	1	42	20	11	71	5	8
14	37	5	43	20	4	72	5	4
15	36	9	44	19	9	73	5	0
16	36	0	45	19	3	74	4	9
17	35	4	46	18	9	75	4	6
18	34	8	47	18	2	76	4	3
19	34	0	48	17	8	77	4	1
20	33	5	49	17	2	78	3	11
21	32	11	50	16	7	79	3	9
22	32	4	51	16	0	80	3	7
23	31	10	52	15	6	81	3	5
24	31	3	53	15	0	82	3	3
25	30	9	54	14	6	83	3	2
26	30	2	55	14	0	84	3	1
27	29	7	56	13	5	85	3	0
28	29	0	57	12	10			

From this table, it appears, that a new born infant, or a child of 0 age, has an equal chance of living 8 years; that a child of 1 year will live 33 more; that a child of 2 years will live 38 more; that a man of 20 years will live 33 and 5 months more; and that a man of 30 years will live 28 more, &c.

It may be farther obferved, 1. That 7 years is the age at which the longeft duration of life is to be expected; for there is then an equal chance of furviving 42 years 3 months; 2. That, at 12 years, one fourth of life is expired, fince we have no reafon to hope for above 38 or 39 years more; 3. That, at 28 or 29 years, we have lived one half of our days, fince there are only 28 more to be expected; and, laftly, That, at the age of 50, three fourths of life are gone, the remaining chance extending only to 16 or 17 years longer.

But thefe phyfical truths, however mortifying, may be alleviated by moral confiderations. The firft 15 years of our exiftence may be regarded as nothing: Every thing that paffes during this long period, is either obliterated from the memory, or has fo little connection with the views and objects which afterwards occupy our attention, that it ceafes entirely to be interefting. The train of our ideas, and even the nature of our exiftence, fuffer a total change. We begin not to live, in a moral fenfe, till after we have learned

learned to arrange our thoughts, to direct them towards futurity, to aſſume a kind of conſiſtency of character ſimilar to that ſtate at which we are ultimately deſtined to arrive. Conſidering the duration of life in this point of view, which is the only real one, at the age of 25, we have paſſed one fourth of our days, at the age of 38, one half, and, at the age of 56, three fourths.

END OF VOLUME II.

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Natural history