On human longevity and the amount of life upon the globe / by P. Flourens ; translated from the French second edition, by Charles Martel.

ON

HUMAN LONGEVITY

AND THE

AMOUNT OF LIFE

UPON THE GLOBE.

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BY ROBERT KNOX, M.D.,

LECTURER ON ANATOMY AND CORRESPONDING MEMBER OF THE NATIONAL ACADEMY OF MEDICINE OF FRANCE.

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PREFACE

TO THE

FIRST EDITION.

In this book, I touch upon some of the most important points of the study, and, if I may use the expression, of the *theory* of life.

Life has been studied in every age; the present begins to study it under its highest aspects.

The question of the *amount of life* has always been discussed, and various opinions maintained, that of the *appearance of life* upon the globe; of the *fixity* of the species; of *species destroyed* and *lost*, these are entirely new questions.

With these questions, I have placed some

others, rather old, but which, I think, I have revived ; these are, *human longevity*, the *formation of life*, and *old age*.

I have revived the question of *human longevity*, by giving a certain sign to the period of increase, and, consequently, a precise measure of the duration of life.

For the study of the *formation of life*, I have substituted that of the *continuity of life*.

Life does not commence with each new *individual ;* it has commenced only once for each *species*. Reckoning from the first *created* pair of each species, life never begins again : it is continued. I solve the mystery, as far as it can be solved, and I determine its place.

As to *old age*, I consider it, in this place under both its aspects : the physical and the moral.

On the physical side, I open to it great hopes : one century of *normal life*, and almost two of *extreme life* ; and all on the simple but rigorous conditions of good conduct, of an existence always occupied, with labour and

study, of moderation, and of *sobriety* in all things.

On the moral side, the prospect is no less beautiful. What happy old men! And what examples of the most delicate and noble faculties unceasingly perfected! Fontenelle, Voltaire, Buffon—Bossuet—if it may be permitted to cite this great name, in questions purely human. I should wish that this book may teach all men the respect *necessary* to *old age*.

To the young man, who will never be instructed, except through old men; to the man of mature years, who will soon reckon, with bitter regret, the present moment, lost for useful action; to the old man, who cannot see himself, without pride, honoured in the age beyond which there is no other in this world: the age in which the soul feels itself nearer to God; the sacred age of life.

PREFACE

TO THE

SECOND EDITION.

UPON the publication of this book, certain objections were made to the views I entertain, which this new edition naturally affords me an opportunity of replying to.

§ 1.

It is said that I have extended the life of man too far. But need I say (and will thinking men excuse it?) that in assigning a duration of one hundred years to the life of man, I have only intended to establish a term, a limit, the experimental and normal limit of this duration?

I have wished to prove a thing that is no sufficiently well understood; which is, that man possesses a great *power of life*, and that, by making good use of his reason, he can greatly extend this *power*.

It has long been remarked that men are more capable of a great effort, than of long-continued perseverance: for this reason, I have sought to render my teaching more persuasive, by placing it in the mouth of a wise old man, who owed his century of life to a strict regimen constantly adhered to.

A passage I have purposely quoted from the *Commentary* of Ramazzini,* has appeared to me sufficient to correct anything that might appear extravagant in the rules of Cornaro.

To the *Cliton* of La Bruyère, "who in all his life has had only two cares, dinner in the morning and supper in the evening, and who appears to have been born only to digest," I prefer, I must confess, my good and abstemious Venetian, who *naïvely* relates, "that from being

cheerful he became sad and dispirited, everything vexed him, he got angry at trifles, so that no one could live with him, and merely because he had exceeded, by one or two ounces, the quantity of food prescribed by his regimen."

How different is *Cliton* from this other character of La Bruyère!

"An old man with a good understanding and a faithful memory, is an inestimable treasure; he is a repertory of maxims and facts; in him may be found the history of his century, invested with very curious circumstances, which cannot anywhere be read; from him we learn rules for manners and conduct, upon which we may safely rely, because they are based upon experience."

§ 2.

From the total duration of life, let us proceed to the special duration of its several ages.

Here I have to encounter a host of prejudices, and my task becomes more difficult.

All our ideas on the *natural limit* of the different ages of life are erroneous.

A frivolous literature, in order to interest us in its heroes, has thought it necessary to anticipate the passions of the ages. They have hurried on the course of life, giving to childhood the passions of youth, and to youth the passions of mature age.

From this we derive young men, of fifteen to twenty, cheated of the sweetest privilege of their age, a peaceful mind; those ripe men of thirty who have never been young, and those old men of fifty who will never be mature men.

We have in us two principles, the *living* principle, and the *thinking* principle.

The *living* principle grows and maintains itself until nearly fifty, and from fifty it declines.

The *thinking* principle grows and expands till the fiftieth year; and from fifty to sixty, seventy, seventy-five, and sometimes still later, it is perfected.

The longer the mind lives, the more it becomes refined.

Until now, the life of man has been divided like that of the other species. We have not taken into account the great principle that distinguishes it, its *integral energy*, which maintains and prolongs the *vital energy* of the ages.

For a long time, much has been said upon the influence of the *physical* over the *moral*;* but too little has been said of the influence of the *moral* upon the *physical*; philosophic observation is too much governed by medical observation.

It is at the moment when the *physical* begins to decline, that the *moral*, in its turn, assumes the sway, confirms and establishes itself, and imparts a new splendour to the second portion of life.

In seeking to enumerate all the precious gifts that man may preserve to himself, I must not forget the happy charm of the first ages.

Ah! why is it, that the present moment

* See the celebrated work of Cabanis, and several other writers.

can never be fully enjoyed with all its advantages ?

That youth, so rich in its future, is so well persuaded that every phase of life requires a regular and complete development, that each age has its blessings, reserved for those who know how to respect it, that it particularly guards itself from renouncing those gentle and noble virtues, of which Vauvenargues has said, " the first days of spring are less beautiful than the dawning virtues of a young man."

§ 3.

I have to meet a third objection : the title *On the amount of life upon the globe* is not approved of.

This title, I am aware, has a certain abstract form, now no longer in use.

We accustom ourselves less and less, every day, to great abstract questions. We descend, more and more, to trifling experiments and minor details, all our sciences are but those of the laboratory, and the great phenomena of nature are forgotten.

"Those who like to enter into the details of the sciences," said Leibnitz, "dislike abstract and general researches; as those who investigate principles rarely enter into particulars. As for myself," he adds, "I equally esteem both."

The object of this book is the study of life. I have examined in succession, the *duration*, the *quantity*, the *forms*, the *formation*, and the *advent* of life.

These questions have all the same form which may be objected to in each.

Every question that is generalized, and rendered in philosophical language, necessarily takes an abstract turn.

It is only by this philosophical language, by this abstract turn, that all great truths pass, little by little, from the special domain of the schools, to the universal domain of the human mind.

I also agree that my question of the *amount of life* is quite new. But is it an error? I

cannot think it. I even venture to hope, that some day I shall be congratulated upon having introduced it. Every new question opens to us a new aspect of things, and great things should be viewed under every aspect.

Henceforth, the study of the *amount of life* will have three laws, as beautiful as simple.

The first is: that since life has appeared upon the globe, the number of *species* has tended to diminish.

The second is: that in proportion as certain *species* disappear, the number of *individuals* in the others increases.

The third is: that the more the influence of man makes itself felt, the more the *superior species* overpower the *inferior species*.

Therefore, some *species* disappear, but the number of *individuals* in the other *species* increases; the number of *individuals* diminishes in the *inferior* species, but increases in the *superior*.

Thus, there is always compensation, and it is the same in *life* as in all the other primary elements of things.

Of the primary elements nothing is lost, neither can anything be lost.

Moreover, it is because our mind is equally incapable of comprehending *creation*, *annihilation*, or whatever it may be, without a superior interference, without a special miracle.

Combinations vary, relations change, movements are retarded or accelerated, the molecules of bodies are united or disunited ; everything in the world is in a perpetual flux of successive modifications, but the principles of things, the primitive and constituent elements, are immutable, and will be so eternally, while HE who has weighed the precise *quantity* for the globe HE had in view, will deem it advisable to maintain and preserve this globe.

CONTENTS.

PART II.

CHAPTER I.

CHAPTER II.

CHAPTER III.

PART III.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

HUMAN LONGEVITY.

CHAPTER I.

ON CORNARO AND AN ABSTEMIOUS LIFE.

We cannot begin with a better authority than that of Cornaro, which is greater, on the subject of longevity and temperance, than that of any other; this good, frail, old man, who, by dint of care, diet, and moderation, and by making *living* the great business of his life, attained to the age of upwards of one hundred years.

His book is the eulogy of sobriety.* And it is to be remarked, that he wrote it at a time when Italy was most given to intemperance. He says:—

"Oh, unhappy Italy! can you not see that gluttony carries off, every year, more victims

* *Discorsi della Vita sobria.* Ven.

than plague, war, or famine? Thy real plagues are too frequent feasts, which are so extravagant, that tables cannot be made large enough to contain the quantity of dishes with which prodigality covers them, so that you are obliged to serve up meats and fruit in pyramids. What folly! what madness! For your own sakes, correct this. Remove this cause of death from among you—this pest unknown to our fathers."

Born with a very feeble constitution, Cornaro could not long resist such excesses. He lost his health. When only thirty-five years old, his doctors gave him but two years to live.

This warning was taken very seriously. Cornaro abandoned his pernicious habits. A life of dissipation gave way to one of regularity; and sobriety succeeded intemperance.

His sobriety has become famous. It was almost excessive. Twelve ounces of solid food, and fourteen ounces of wine each day, were, for more than half a century, all his nourishment; this agreed so well with him, that during the whole of that half century, he was never ill. "I have always been healthy," he says, "since I became abstemious. I also found it better for me," he adds, "not to give way to grief, and to

banish everything from my mind which might cause it. If I have, occasionally, been neither prudent nor philosophical enough to avoid falling into any of those conditions which I wished to shun, regimen in diet, the influence of which is most direct, protected me from the grievous consequences of these little irregularities."

I find, in Cardan, an observation upon Cornaro which is unjust.

"It seems," says Cardan, "that Cornaro has wished to deprive us of the full knowledge of his regimen, and contented himself with letting us know that he had found a wonderful one, since he has not told us whether he took this quantity all at once, or in portions; nor even if he varied his diet; on this subject he has spoken even more obscurely than Hippocrates."

Nothing of this is correct. Cornaro has not sought to conceal anything from us. Cardan sees the marvellous in everything. Cornaro, being so much pleased with his regimen, recurs to it in almost every page of his book, and tells us everything about it.

Firstly, he informs us, that he took this quantity in two, and even in four portions. "And thou, Nature, mother of all human

beings, who lovest so much the preservation of our existence, that thou givest to the old man the facility of living upon little food, and makest him understand that if, in the vigour of his age, he took two meals a-day, he should now divide them into four, so that his stomach may have the less labour in digesting. I cannot too much admire thy wisdom and prudence! *I follow thy counsel, and find it well.*"

He then tells us, *he varied his food.* "This is what I live upon: I eat bread, mutton, partridges, &c., &c. All such articles of food are suited to old men, who, if they are wise, will be contented with them, and not seek for others."

I ask, what more could Cardan desire? But that is not all. Cornaro is so determined not to omit anything which concerns his regimen, that he relates, in full detail, how, having consented, in deference to his friends, to take fourteen ounces of food a-day, instead of twelve; this trifling addition of two ounces nearly cost him his life.

"About four years ago, I was earnestly requested to do a thing which had nigh cost me very dear. My relations, whom I love, and

who have a real regard for me; my friends, to whom I have always been obliging, even the doctors, who are usually the oracles of health, leagued together to persuade me that I ate too little, that the nourishment I took, at my advanced age, was insufficient, and that I ought, not only to sustain my life, but it was necessary also to invigorate it, by eating a little more than I did. It was in vain for me to represent to them that nature is contented with little; that, this little having kept me for a long time in good health, habit had become a second nature with me. All this had no effect upon them. Wearied with their pertinacity, I was obliged to gratify them. Thus, from being accustomed to take, in bread, soup, yolks of eggs, and meat, the weight of twelve ounces daily, I increased that weight to fourteen, and from drinking fourteen ounces of wine, I increased the quantity to sixteen.

"This augmentation of food was so injurious to me, that, from being very cheerful, I became sad and dispirited; everything vexed me; I got angry at trifles, and no one could live with me. At the end of twelve days, I had a violent pain in my stomach, which continued

twenty-four hours. It is unnecessary to ask if they despaired of my life, or if they repented the advice they had given me."

Such, then, was the regimen of Cornaro; twelve ounces of solid food, and fourteen ounces of wine a-day. He even diminished this quantity with age, and at last made a meal of the yolk of one egg, and afterwards made the yolk of a single egg serve for two meals. The whole *marvel* of his regimen was moderation.

Let us add, that, although he placed sobriety above all other precautions, he neglected none.

"I take care," says he, "to guard against the extremes of heat and cold. I never take violent exercise. I have abstained from late hours. I have never lived in places where the air is bad, and I have also carefully avoided being exposed to violent winds, and to extreme heat of the sun."

Morality greatly assists nature. Cornaro chose two of the gentlest exercises of the mind and heart—literature and benevolence.

"I have the good fortune," says he, "to enjoy frequent conversations with learned men, from

whom I always derive new ideas.* I see new things with curiosity. I take a fresh pleasure in re-viewing things which I have seen before. If I may be allowed to name trifles, I may mention, that at the age of eighty-three, the temperate life I lead has preserved to me sufficient activity of mind and gaiety to compose a play, which is very amusing, without offending good taste."

Such were the pleasures of his mind. His heart enjoyed others still more refined. He saw himself surrounded by eleven little children, whose games he loved to contemplate; by his tenants, to whom he gave the means of abundantly enjoying the necessaries of life; in ploughing uncultivated lands, draining marshes, and watering and manuring fields, become sterile by the aridity of their soil.

He had assisted in fortifying and embellishing Venice.† "That pleasure," says he, "innocently flatters my vanity, when I reflect that I

* He was united in the bonds of friendship with the celebrated philosophical poet Speroni. The architect Falconetto visited him, and the comic poet Beolco, called Ruzzante, was a frequent guest at his table.

† By his studies on the lagunes of Venice. See his "Trattato delle acque," (1560).

furnished my countrymen with useful means of fortifying their port—that these works will last many centuries—that they will contribute to render Venice a famous republic, a rich and matchless city, and will serve to perpetuate to it, the beautiful title of 'Queen of the Sea.'"

Lastly, to all these means of securing long life—moderation, precautions against heat and cold, occupation of the mind and heart, &c., there was added another, which operated unknown to Cornaro, but was none the less efficacious: I mean the secret pleasure of struggling with nature, and overcoming her; of living, in spite of his constitution and the prognostications of his physicians; of owing his life to himself, to his resolution, to his skill, and of considering every new day of existence as another triumph for his self-love.

Then, he never ceases speaking of what he calls his *beautiful life;* of *the victory he has gained;* he is proud of living. He exclaims: "What I am going to say will appear impossible or hard to believe; nothing, however, is more true: it is a fact known to many persons, and worthy of the admiration of posterity. I have attained my ninety-fifth year, and find

myself as healthy, merry, and happy as if I were but twenty-five."

"Nothing," says Cornaro, "is more advantageous to man, than long life;" a maxim that none will dispute; but the reasons he gives are curious. "If one is a cardinal, he may become pope by age; if of importance in the republic, he may become chief of it; if wise, or excelling in any art, he may excel still more."

He then gives reasons of a more elevated character. "That," says he, "which gives one the truest pleasure, is to perceive that age and experience may render a man wiser than the schools can make him. We do not know the value of ten years of healthy life at an age in which man can enjoy all his faculties, and profit by all his experience. To speak only of the sciences, it is certain that the best books we possess have been composed in those ten last years which libertines most detest; it is certain that the mind matures as the body grows old; science and art would have lost much, if all the great men who cultivated them had shortened their lives ten years."

I quite agree with Cornaro on this point—that *the mind is matured as the body grows old.*

Every age has a mental power of its own. There are discoveries which a young man may make, there are others which can be made only by a man of mature years. Galileo, when but eighteen or twenty years old, discovered the equal duration of the oscillations of the pendulum.* Pecquet, while yet at school, discovered the *reservoir* that bears his name, the *reservoir of chyle.* Harvey was fifty when he published the most beautiful book in modern physiology, his work on the "Circulation of the Blood." Buffon was seventy-one when he wrote the most perfect of his works, "The Epochs of Nature."

We can very well understand how a young man makes an unexpected, unforeseen, and brilliant discovery; for what is requisite?

* "It was in 1582, and when eighteen or twenty years old, that Galileo made his first, and one of his most beautiful discoveries. Being one day in the metropolitan church of Pisa, he remarked the regular and periodical motion of a lamp suspended from the ceiling of the dome. He observed the equal duration of its oscillations, and proved it by repeated experiments. He immediately comprehended the use of this phenomenon for the exact measure of time, and as the idea did not escape his memory, he made use of it fifty years after, in the construction of a clock for astronomical observations." —Biot, "*Biographie Universelle,*" Art. "Galileo."

quick penetration, a sudden thought, and these belong to youth. But to discover the *circulation of the blood!* the complicated result of a number of different facts, it was necessary to have a capacity for attention, meditation, and a power of combination, which belong only to mature years.

The age of man is one and manifold. It is one by its nature, it is manifold by its faculties. And the development of these faculties is not simultaneous, but successive. Those which rule at one age are not those which dominate at another. Whoever, from this point of view, will follow the play of our faculties in writers, such as Bossuet, Fontenelle, Voltaire, men who have lived to an old age, and written a great deal, will perceive their order of succession, that, whilst some grow feeble, others expand, and perhaps he will find that those which expand in old age are not the least precious.

Cornaro's book is composed of four "Discourses."* The third has a distinct title:

* First published separately; these four "Discourses" were then united under the collective title of "Discorsi della vita sobria," &c. The first edition composed of "Discourses," appeared at Padua, in 1558.

"*Lettre à Monseigneur Barbaro, patriarche d'Aquilée,*" and begins with these words: "It must be confessed that the mind of man is one of the most sublime works of the Deity."

He wrote the first when eighty-three years of age, the second at eighty-six, the third at ninety-one, and the fourth at ninety-five. The whole four are nothing but repetitions of each other; but this repetition does not fatigue, for as the argument is to prove that *the duration of life* depends upon *sobriety*, the more the book repeats and establishes it, the more it proves.

The author himself says gracefully, in his "*Lettre à Barbaro,*" "It is true, I shall tell you nothing new upon the subject, but I have never told it to you at ninety-one."

In fact, he says at ninety one, "I will inform you, then, that a few days ago, some doctors of our university, philosophers as well as doctors, came to inform themselves of the manner in which I nourished myself, and they were very much surprised to see me still full of health and vigour, that all my senses, my memory, my heart, my judgment, the sound of my voice, are perfect; that my teeth have not changed

since my youth, that I write with my hand seven or eight hours a-day, and that I pass the rest of my day in walking on foot and enjoying all the pleasures permitted to a respectable man; even to music, in which I take my part very well. Ah! how beautiful you would think my voice, if you heard me sing the praises of God to the sound of my lyre;" to say this at ninety-one years of age, proves more than to say it at eighty-six or eighty-three, and to repeat it at ninety-five proves much more. Besides, Cornaro could have repeated it again at a hundred years of age. One of his grand-nieces, a nun of Padua, tells us, in a "*Notice*," which she has devoted to her uncle, "That he continued healthy, and even vigorous, until he was a hundred years old. His mind," she continues, "did not at all decline; he never required spectacles—he did not become deaf. And, what is no less true than difficult to believe, his voice remained so strong and harmonious, that at the close of his life he sung with as much power and delight as he did at twenty." Cornaro died on the 26th of April, 1566. I have not been able to find the precise date of his birth. The "*Biographie Univer-*

selle" says he was born in 1467. According to this, he would not have lived quite a hundred years. The "Notice" written by his niece says positively *a hundred years;* another "Notice" says *more than a hundred years;* a third says that he lived to *a hundred and five.*

Cornaro was born at Venice, of an illustrious family, to whom that city is indebted for three of its Doges; the Isle of Cyprus for a queen, Catherine Cornaro; and Italy a woman most celebrated in science, Helena Cornaro, who, in 1678, took the degree of Doctor in Philosophy, with much solemnity, in the Cathedral of Padua.

Involved in the disgrace of one of his relations, he was excluded, not from the city of Venice, but from following any profession in it. He quitted it of his own accord, and went to live at Padua. "I live," says he, "in a house which, besides being built in the most beautiful part of Padua, may be considered as one of the most convenient. I have had constructed in it, winter and summer apartments, which afford me safe protection against excessive heat and cold. I walk in my garden, beside my rivulet, near my espaliers."

Such was Cornaro. His book will always afford us a useful example of what a rational mode of living can do towards prolonging life. I say a *rational mode*, for he only adopted this excessive self-imposed sobriety, because it agreed with him—he had too much good sense to impose it on others. "I eat very little," says he, "because my stomach is delicate, and I abstain from certain dishes because they disagree with me. Those to whom they are not hurtful, need not deprive themselves of them; they may be allowed the use of them, but they should abstain from eating too much of whatever excites the appetite."

The most competent of the commentators of Cornaro, Ramazzini, a skilful physician, says, very judiciously: "It would be too severe to prescribe such rules to persons who enjoy perfect health, it would not even be good for the public. Let old men do so after they have passed the best part of their lives in the service of the republic, but it is not just to include young men in these observations. How will they be able to serve their prince and country, either in embassies or armies, where the fatigue of marches is required? How will a doctor be able to visit his

patients every day? How will a lawyer be able to discharge his duties? Again," says Ramazzini, "If any one asked me what food to use, in what quantity, and at what times he ought to take it to sustain his health, I should refer him to his stomach, which is doubtless more capable than any one of giving him good advice on that subject."

Since I have now quoted Ramazzini, I cannot pass over in silence a sentence in his "Commentary," which, in its turn, has much need of comments. In one place he calls Harvey's book on the "Circulation of the Blood," a divine book, and certainly it is not against that part I protest, but he says elsewhere, "the ancients were entirely ignorant of the circulation of the blood, and we are under obligations to Harvey, the English Democritus, for having been the first to publish it, after he had drawn it from those two excellent sources, Fabricius and Paul Sarpi, both professors of Padua, who had made so many experiments upon all sorts of animals."

This paragraph, thrown in incidentally, which is not of much importance, especially coming from the pen of a professor of Padua, as Ramazzini then was, induced me to make some new researches, which have, at length, enabled

me to award Fabricius, Harvey, Pecquet, and others, what is due to each in the discovery of the circulation of the blood and chyle.*

I return to Cornaro. A question his book naturally gives rise to, is that of the duration of human life; and first, if there be any way of prolonging life? of *prolonging* it, so as to make it go as far as the constitution of man permits. Yes! doubtless, there is, and a very sure one—that which Cornaro has just given us, *sobriety*. By *sobriety*, I mean a well regulated life; a rational mode of living is the means, the *sure* means of prolonging life. But to *extend it*, that is to say, to make it last beyond the term ordained by the constitution of man; no, doubtless, that cannot be done.

Cardan gravely tells us, that trees only live longer than animals, because they do not take any exercise.† Exercise increases transpiration, transpiration shortens life; to live long then, we need only remain still. We may excuse Cardan for this. We can less easily excuse Bacon,

* See the author's "*Histoire de la Découverte de la Circulation du Sang*," Paris, 1854.

† Cardan. "*Plantæ cur animalibus diuturniores:* De Subtilitate," p. 826.

the father of "Experimental Philosophy," for the same notion, and for the *oily unctions* which he prescribes to prevent transpiration. Maupertuis wished to cover the body with *pitch*, and Voltaire laughed at Maupertuis.

Every species of animal has its determined duration of life. This was well recognised by Buffon: he even sought, and was, I believe, the first who did so, the physiological law of this duration. "As the stag," says he, "is five or six years in growing, so he lives seven times five or six years; that is to say, thirty-five or forty years." He says elsewhere, "the duration of life, to some extent, may be measured by the time of growth; an animal which acquires all its growth in a short time, perishes very much sooner than another which is longer in growing." Of man, he says, "the man who does not die of disease, reaches everywhere the age of ninety or a hundred years."

Cornaro thought upon the duration of the life of man, like Buffon, only upon less learned grounds. "When man," he says, "has attained the age of forty or fifty, he must know that he has reached half the term of his life." He says again, "I am certain of living more than one

hundred years." People *born with a good constitution*, must, it seemed to him, reach at least the age of six score, and it was only because he was *not so well constituted* that he made up his mind not to live *longer than a century*.

It is about fifteen years ago since I entered upon a course of researches into the physiological law of the duration of life, both in man and in some of the domestic animals. The most striking result of this labour, as will soon be shown,* is, that the normal duration of the life of man is one century. A hundred years of life, is what Providence intended for man ; it is true, few men reach this great term, but yet how few do what is necessary to attain it. With our customs, our passions, our miseries, man does not die—he kills himself. "What folly, what madness," Cornaro might again exclaim. In spite of this, we see centenarians. Everywhere men live to one hundred years, with a good constitution, and even with a bad one. Fontenelle, Cornaro, and others are proofs of it. Haller, who has collected a great number of examples of long life, reckons up more

* In chapter III. on "Human Longevity."

than a thousand instances of individuals having attained the age of 100 to 110, sixty of 110 to 120, twenty-nine of 120 to 130, fifteen from 130 to 140, six from 140 to 150, and one of 169.

Man's first desire is health; he then wishes for long life. He covets these two blessings, therefore he must be constantly reminded that they depend upon himself.

We cannot speak of Cornaro without referring to Lessius.

Lessius was a very creditable and learned monk, with a constitution as feeble as that of Cornaro, whose book he read. Much struck with his *sobriety*, he put it in practice, and, like Cornaro, was rewarded with *long life*.

Lessius himself relates how this came about. "Some very skilful physicians came to the conclusion that I could not possibly live longer than two years. They prescribed a regimen which made me a great deal worse. At this time there fell into my hands a work upon 'sobriety,' written by an Italian, a man of great reputation, much fortune, and still more wit."

Lessius read this work, *with singular pleasure*—he translated it into Latin, and added, as

a preface, a little treatise on "The Advantages of Sobriety."*

This treatise has every earnest and sensible quality that could be desired. There is in it more of a slightly poetic enthusiasm than of persuasiveness; and its style is finely animated with a calm joy.

Cornaro finishes his first "Discourse" thus: "Such is divine sobriety, friend of nature, daughter of reason, sister of virtue, companion of a noble, modest, temperate, regular life, and strict in all its actions. It is the root of life, of health, of joy, of address, of skill, and of every action worthy a noble mind. Laws, divine and human, favour it; irregularities, and the perils attendant upon them, fly before it, as the clouds before the sun. Its beauty attracts every noble heart; its practice ensures to all a happy and lasting existence; we know it to be the amiable and benign guardian of life, be it rich or poor; it leads the rich to observe moderation, the poor, economy; the

* "Hygiasticon, seu de verâ ratione valetudinis bonæ et vitæ, una cum sensuum judicii et memoriæ integritate, ad extremam senectutem conservandæ," Antwerp, 1613. Lessius was born, at Brabant, in 1554; he died in 1623.

young man to a firmer and surer hope of life; it protects the old man from death. Sobriety purifies the feelings, quickens the faculties, cheers the mind, strengthens the memory. The soul, almost freed by it from its earthly load, enjoys a larger liberty."

At ninety-five, the last words of his fourth and last "Discourse" still display his *naïve* regard for *length of days*.

"I conclude by declaring that great age may be so useful and agreeable to men, that I believe I should have been wanting in charity if I had not taken pains to point out by what means they may prolong their days, and as each can boast of a happiness of his own, I shall not cease to cry to them, 'Live—live long!'"

CHAPTER II.

ON OLD AGE.

I NOW propose to study old age under the four following relations: *physiology*, *psychology*, *pathology* and *hygiene*.

§ I. PHYSIOLOGICAL STUDY OF OLD AGE.

The life of man divides itself into two nearly equal parts, one of increase, and the other of decrease.

Each of these two parts is divided into two others, and hence the four ages of life—infancy, youth, manhood, and old age. Lastly, each of these two ages is sub-divided into two. There is a first and a second infancy, a first and a second youth, a first and a second manhood, and a first and a last old age.

It is not easy to determine the precise duration of each of these ages and sub-ages.

I propose, however, the following durations: for the first infancy, from birth to the tenth year, this is infancy, properly so called; and for the second, from ten to twenty, this is adolescence;* for the first youth, from twenty to thirty, and for the second, from thirty to forty; for the first manhood, from forty to fifty-five, and for the second, from fifty-five to seventy. Manhood, taken as a whole, is the period of strength, and, as the word so well expresses it, the *virile* epoch of the life of man. At seventy, the first old age begins, and continues to eighty-five, and at eighty-five, begins the second and last.

What renders it difficult to mark the term at which each age ends, is that there is no repose, no pause between them. The passage from one to another proceeds insensibly. We look at a growing plant, with a desire to see it grow. This action is so very gradual, that it escapes the closest observation. Leave the plant but for a short time, upon returning to it, we find it has very much increased.

* Or puberty. Strictly speaking, puberty is only a very important phenomenon of adolescence.

Life is often compared to a river, because our years follow each other, and vanish like the ripples on its surface. A flood without ebb bears us onward; "we can never cast anchor in the river of life," as Bernardin de St. Pierre finely and profoundly observes.

The ancients divided life into *septenaries*. This was a result of the famous doctrine of *crises*, in which everything was governed by the number seven.

This doctrine of crises was itself the fruit of a still older doctrine, that of *numbers*. The absurd idea of the efficacy of numbers soon passed from philosophy to medicine, and, from the first, corrupted the clear and careful observation of the relation between time and crises. Instead of subordinating the days to the crises, they wished to subordinate crises to days—to days prescribed by the system.

We see the trouble Galen gave himself to arrive at this; and, as Bordeu wittily says, "to save his seventh day." The doctrine says that the patient ought to die on the sixth day: he dies on the seventh. Then the doctrine is wrong. Not at all! it is the patient, whose

constitution resisted the disease longer than it ought to have done. Before Bordeu made fun of Galen, Molière had laughed at Hippocrates.

M. Tomès.—How is your mistress's coachman?

Lisette.—Very well. He is dead.

M. Tomès.— Dead?

Lisette.—Yes.

M. Tomès.—That's impossible! Hippocrates says that diseases of this sort only terminate on the fourteenth or twenty-first day; and it is only six days since he fell sick.

In the doctrine of crises there is some truth, nay, much truth; for every disease has its regular progress, its prescribed course, and its marked termination, after a fixed duration, according to the nature of the malady, and not to the peculiar efficacy of days.

The true side of the doctrine has brought its chimerical side down to our own times. Cabanis again, divides life into periods of seven years. Infancy terminates at seven years. Adolescence at fourteen. Youth at twenty-eight. Maturity at forty-nine, &c. But Cabanis next says, with regard to adolescence,

"it is often prolonged to twenty-one."* With respect to youth, "generally, it only terminates at about thirty-five,† and mature age is often prolonged till fifty-six."‡

Cabanis, in this case, does just the reverse of Galen. Galen made the observations conform to the doctrine; Cabanis, as far as he can, makes the doctrine conform to the observations.

I prolong the duration of first infancy to ten years, which should be called *the period of dentition*, because it is only at nine or ten years of age that the second dentition is finished.‖

I prolong adolescence to twenty, because it is only at twenty that the development of the bones is completed, and consequently the growth of the body in length.

While the bones are not united at their *epiphyses*, the body continues to grow. When once the bones and the *epiphyses* are united, then the body ceases to grow; and it is at about

* "Rapports du physique et du moral," &c., Vol. I., p. 276. 2nd edition.

† Ibid, p. 286.

‡ Ibid, p. 295.

‖ The *second dentition* is not entirely completed at nine or ten, but the great effort of dentition is made. There are still four teeth which will appear much later.

twenty that, in man, this union takes place.

I prolong youth to forty, because it is only at about forty that the increase of the body in size terminates. After forty, the body no longer increases in size, strictly speaking, the augmentation of bulk which then takes place, is not, in fact, a real organic development; but only a mere accumulation of fat.

Buffon well observes: "This extension is not a continuation of development, or of internal growth of each part by which the body would continue to acquire size in all its organic parts, and consequently more strength and activity; but it is a simple addition of superfluous matter, which swells the bulk of the body, and loads it with a useless weight. This matter is fat."

After growth, or rather after the developments in length, and in size, I find still a third, not indicated by physiologists, but which appears to me none the less real. I mean that of the deep interior work, which acts in the most hidden parts, and rendering all these parts more complete, *firmer*, also renders all the functions more certain, and the entire organi-

sation more perfect. This latter work, which I call the work of *invigoration*, takes place from forty to fifty-five; and once effected, continues, more or less, till sixty-five or seventy.

At seventy, old age begins. But physiologically speaking, what then takes place by which we can perceive that it begins? What is the fact, the character that reveals it? This is the first question I propose to myself.

The ancient physiologists distinguished, with good reason, two kinds, or rather two provisions of strength; the forces in *reserve*, and the forces in *use*, or, as they said, *vires in posse et vires in actu*, or as Barthez describes it, the *radical* forces, and the *acting* forces.

In youth there is a great deal of force in reserve; it is the progressive diminution of this disposable fund that constitutes the physiological character of old age.

Whilst the old man only employs his *active* forces, he does not perceive the loss of anything; if he goes ever so little beyond this usual and active power, he becomes fatigued and exhausted; he feels that he has the hidden resources, the reserved and superabundant powers of youth, no longer. "When we know," says M. Reveillé-

Parise,* " that in every one of our organs, there are two particular forces—although, in fact, they are identical—the one daily, habitual, always employed—the other, latent, in reserve, and which only shows itself on extraordinary occasions—we are induced to avoid committing excess of any kind. It is in these excesses, in fact, that we use the forces in reserve; but as these forces are repaired slowly, and with difficulty, we comprehend that we must have recourse to them as seldom as possible, and this is specially true for old men, whose organization is enfeebled by years. After exhibiting the physiological character of old age, I inquire if there is a determinate organ, by which we can say it commences.

According to M. Reveillé-Parise, old age commences at the lungs.

" If we reflect," he says, " that it is from the blood, that life derives the principles which maintain and repair it—that the more vigorous, plastic, and rich in nutritive principles, so much the more organic life increases and manifests itself, and that the organ of sanguification,

* Traité de la Vieillesse Hygiènique. 8vo. Paris, 1853.

of *hematosis*, is the organ of respiration, we shall be compelled to admit the opinion, that the age of general decline commences with the decay of the lungs, that the one is the result of the other."

"This fact," he adds, "is so evident to my senses, that I am fully convinced that the beginning of the period of decrease of the animal economy, is in the respiratory organs themselves, in a word, that this is the first origin, the starting point of old age."

I cannot adopt this opinion.

Old age does not commence at an organ. It is not a local but a general phenomenon. All our organs grow old. Moreover, it is not always at the same organ that we feel the first effects of age, it is sometimes one, sometimes another, according to the individual constitution. We know for certain, that the lungs is one of the most important organs; one of those whose function is the most immediately essential to life, and that the more important an organ is, the more its feebleness influences all the others.

I also inquire—what is the mechanism, the mode according to which old age operates?

Life is an action. The principle of life, what-

ever may be its nature, is eminently and visibly a principle of excitation, of impulsion, a motive power. "It is taking a false idea of life," says Cuvier, "to consider it as a simple link, which binds the elements of the living body together, since, on the contrary, it is a power which moves and sustains them unceasingly. These elements," he adds, "do not for an instant preserve the same relations and connexions, or, in other words, the living body does not for an instant keep the same state and composition." These last words are very remarkable, particularly coming from the pen of so sound a writer, but are, however, only the new enunciation of a very old idea in science.

Long before Cuvier, Leibnitz said, "our body is in a perpetual flux, like a river, particles enter and leave it continually," and long before Leibnitz, physiologists had compared the human body to the famous ship of Theseus, which was always the same ship, although, from having been so often repaired, it had not a single piece with which it was originally constructed.*

* "One may well say of a given individual, that he lives and is the same, and is spoken of as an identical being, from his earliest infancy to old age, without reflecting that he does

The truth is, that the idea of the continual renovation of our organs has always existed in science, but it is also true, that it has always been disputed.

I believe I have proved this recently, by direct experiments.

I have shown that the mechanism of the development of the bones consists *essentially*, in a *continual mutation* of all the parts composing them. This bone, which I look upon, and which develops itself, has not at this moment any of the particles which it formerly had, and it will soon have none of those it now has. And, in all this perpetual change of material, its *form* changes very little. This is one of the first and fundamental laws which govern the organization. In everything which has life, the form is more persistent than the material.

Buffon had already remarked it. "That which is most constant, most unchangeable in nature," says he, "is the impress or mould of each species, both in animals and in plants; that which

not contain the same particles, which are produced and renewed unceasingly, and die also, in the old state, in the hair and in the flesh, in the bones and in the blood—in a word, in the whole body."—*Plato*, "*The Banquet.*"

is most variable and corruptible, is the substance of which they are composed."

Cuvier has further developed this fine idea. "In living bodies," he remarks, "no molecule remains in its place; all enter and leave it successively; life is a continual whirlpool, the direction of which, complicated as it is, remains always constant, as well as the species of molecules which are drawn into it, but not the individual molecules themselves; on the contrary, the actual material of the living body will soon be no longer in it; and yet it is the depository of the force which will constrain the future material in the same direction as itself. So that the form of these bodies is more essential to them than the material, since this latter changes unceasingly, while the other is maintained."

We may say that this grand view of the continual mutation *of the material*, with Buffon and Cuvier, the fruit of an abstract meditation rather than of the facts themselves becomes a striking evidence, and an actual fact in my experiments.*

* See the author's "Théorie expérimentale de la formation des os."

If I examine, then, the increase in thickness of the bone of a young animal, which, after being subjected to a *diet of madder** for a month, has been supplied with ordinary food for several months, I see in the interior a red layer; but before this red layer was formed, there was a white one, which had now disappeared. This red layer, which is now the oldest, was, not long ago, the newest; and when it was the newest, which it will not long be, all the white layers, since formed, did not yet exist.

The increase in length gives me similar, and, perhaps, still more surprising facts. The extremities of the bone, which are called its *heads*, change entirely during its growth. In fact, the *head*, or extremity of the bone, which was found at the point where the red layer ends, and which itself had then a red layer, is gone, it has been absorbed; and that which now exists, did not then. Everything, therefore, in the bone changes during its growth; all its particles appear and disappear; all are successively formed and absorbed; and each, as is admirably said by Cuvier, is the *depository*, while it exists, of the force, which will

* That is to say, food mixed with madder.

constrain that which succeeds it, *to follow in the same direction as it*, and to assume the same form.

Voltaire, whose quick mind seizes, repeats, and adapts everything to his own views, says, with respect to the words of Leibnitz, cited above: "We are, actually and physically, like a river, all the waters of which flow in a perpetual flux. It is the same river by its bed, its banks, its source, its mouth, by everything which is not itself; but, as at every moment it changes the water, which constitutes its existence, there is no identity, it is never the same river."

To this latter remark I reply, very true for the river, but not so for a living body. That which constitutes the *being* of a living body; and, consequently, its identity, its *sameness*, is precisely what does not change; that is, its form, its force, that force, of which the material is only the *depository;* that which changes, is precisely what is not itself, that is, the *material.*

§ II. PSYCHOLOGICAL STUDY OF OLD AGE.

Who has not read, again and again, Cicero

"On Old Age," the book of which Montaigne said, "it gives one an appetite for old age."

Another book on old age, the effect of which is also very persuasive, is that of Louis Cornaro, that wise and amiable old man of whom I have spoken in the preceding chapter.

The book of Cicero persuades, because it is written by the hand of a master, and under the inspiration of an elevated philosophy. That of Cornaro convinces, because it is written by a man who has lived a hundred years, always lively, cheerful, and enjoying his life. This fact persuades even more than the book.

The moral aspect of old age is its best side. We cannot grow old without losing our *physique*, nor also without our *morale* gaining by it. This is a noble compensation.

In reading M. Reveillé-Parise, I perceive with pleasure, that the *durations* he assigns to different ages, guided only by observation, approach very nigh those to which physiology has led me. We differ only in words. "In a green old age," he says, "when from fifty-five to seventy-five years, and sometimes more, the life of the mind has a scope, a consistence, and remarkable solidity, man has then truly attained

to the height of his faculties." I agree with all this; only I do not call old age the age that commences with fifty-five years; and I prolong until eighty, or even to eighty-five, what M. Reveillé-Parise calls the *green* old age, and which I name the *first* old age.

M. Reveillé-Parise passes in review one after the other, the reproaches which have been directed against old age, and he replies by the best proofs—by examples and facts.

Old men are reproached with losing their relish for occupations which had been most dear to them. M. Reveillé-Parise replies by the example of Duverney, the celebrated anatomist of the Jardin Royal. "At eighty, he renewed," says Fontenelle, "his powers and youth, to reappear in our assemblies, where he spoke with all the vivacity he was ever known to possess, and which was no longer expected. A great passion is a species of immortal soul of its kind, and almost independent of the organs."

Old men are reproached with thinking only of the present, of themselves, of being indifferent to everything that may happen; and yet, as M. Reveillé-Parise properly says, how many old men plant trees for future generations!

"Mes arrière-neveux me devront cet ombrage."

Old men are reproached with want of imagination, but they have reason; and yet!

Voltaire it is true, was only fifty when he wrote these beautiful lines:

"Si vous voulez que j'aime encore,
Rendez-moi l'âge des amours," &c.

But he was *seventy-eight* when he wrote the following, redolent with philosophic tact:

"Lorsque le seul puissant, le seul grand, le seul sage,
* * * * *
Descartes prit sa place avec quelque fracas,
Cherchant un tourbillon qu'il ne rencontrait pas."
* * * * *

La Fontaine, when upwards of *seventy-three* wrote these lines, still so youthful:

"A qui donner le prix? Au cœur, si l'on m'en croit.
Que n'ose et que ne peut l'amitié violente?
Cet autre sentiment que l'on appelle amour
Mérite moins d'honneur; cependant chaque jour
Je le célèbre et je le chante."

But, it may be said, I only quote exceptions. Not at all: these are not exceptions, but revelations. Here the exception is the talent,

that great revealer of secret forces, and of treasures concealed in the human mind.

The clear and conclusive examination of these *revelations*, will give us the *psychology of old age*. The *psychology of age* is yet to be done —an important but difficult task, which will demand an analysis as attentive as delicate.

M. Reveillé-Parise has observed much, but more under the moral, than under a precisely psychological relation. I remark in his book the following traits. "The old man smiles sometimes, but seldom laughs. Kindness, that charm of old age, is often found under a calm and severe exterior; for the first comes from the heart, and the second from the physical being which is enfeebled.

"Patience is the privilege of old age. A great advantage to the man who has lived is, that he knows how to wait. Every thing in the old man is subjected to reflection, &c."

I stop at this last observation, which is entirely psychological. The mind has two great sources of action, attention and reflection. In youth, attention, vivid, active, always prompt, seizes upon everything; but reflection is wanting. In mature age, attention and reflection are

united, and give power to ripe age. In old age, attention fails, but reflection increases. Old age is the age in which the human heart falls back upon itself, and knows itself best.

I find in Buffon, and in a place where certainly I should not have looked for it, in one of those *additions*, so often useless, with which he has overloaded his volumes, a page upon old age which possesses remarkable beauty.

In reading Cicero, it is too evident that he has taken the praise of old age for his theme, Cornaro, in praising old age, praises himself, and that puts me on my guard. In Buffon, I find an author more disinterested, more impartial. He was only *seventy* (and this was young for Buffon) when he wrote the passage I am about to quote. He was in good health, in the full strength of body and mind, and, what in this case says much more, of talent. This talent soared, and soon displayed itself in his most remarkable work, "The Epochs of Nature." Buffon also, fairly calls old age a *prejudice*,* a very characteristic word.

But this is not all. Without *our arithmetic*,

* "The philosopher must regard old age as a prejudice."

we should not, according to Buffon, know that we were old. "Animals," he says, "do not know it; it is only by our arithmetic that we judge otherwise."

I shall now give the quotation alluded to. Remarking that Buffon is animated, is brought *en scène*, speaks, scolds the young men—those young men ever so prompt to believe, and to give every advantage.

"Every day that I rise in good health," says Buffon, to them, "have I not the enjoyment of this day as fully as you? If I conform my actions, my appetites, my desires to the simple impulses of wise nature, am I not as wise and as happy as you? And the view of the past, which causes so much regret to old fools, does it not afford me, on the contrary, the pleasures of memory, agreeable pictures of precious images, which are equal to your objects of pleasure. For these images are sweet; they are pure; they leave upon the soul only pleasing remembrances: the uneasiness, the disappointments, the sorrowful troop which accompanies your youthful pleasures, disappear from the picture which presents them to me. Regrets must disappear also;

they are the last sparks of that foolish vanity that never grows old.

"Do not let us forget another advantage, or, at least, a large compensation, in the happiness of advanced age; which is, that there is more gained for the moral, than lost for the physical. All is gain to the moral; and what is lost to the physical is fully compensated for.

"Some one asked the philosopher Fontenelle, when ninety-five years old, which were the twenty years of his life he most regretted? He replied, that he had little to regret; but the age at which he had been most happy was that from forty-five to seventy-five. He made this avowal in sincerity, and he proved what he said, by natural and consoling truths. At forty-five, fortune is established; reputation made; consideration obtained; the condition of life established; dreams vanished or fulfilled; projects miscarried or matured; most of the passions calmed, or at least cooled; the career in the work that every man owes to society nearly completed; enemies, or rather, the envious are fewer, because the counterpoise of merit is known by the public voice, &c., &c."

In reading Buffon, I am always struck by the

tone of respect with which he quotes Fontenelle; and he quotes him frequently. Sometimes, he re-produces, without quoting him; but, by a certain attraction, more *dégagée*, more lively, less solemn, we quickly recognize the author of the "Eloges." *Incessu patuit.* . . .

"Everything," concludes Buffon, "everything that is moral is to the advantage of age; a truth which will appear still clearer, if we oppose to this peaceful picture of old age that other picture of virile age, so troublesome, that Buffon has elsewhere traced, and which is known to every one:

"It is at this age that the most contentious cares of life are born; for we take a condition, that is, we are embarked by chance or choice in a career which it is always shameful not to adopt, and often very dangerous to occupy with credit. We walk, then, between two rocks, equally dangerous. Glory, that powerful mover of all great minds, beheld from afar as the splendid goal which must be attained by brilliant and useful labours: it is now only an unattractive object for those who have attained it, and a vain and deceitful phantom for those who are left at a distance."

§ III. PATHOLOGICAL STUDY OF OLD AGE.

The early physiologists distinguished the forces in *reserve*, from the forces *in use*;* in the same way that the ancient physician, by a similar separation, distinguished the *oppressed* forces from the *resolved* forces; the *oppression of forces* from the *resolution of forces.*

In the diseases of youth, the dominant condition is the *oppression* of forces, and it is then necessary to bleed; in proportion as the blood flows, the *oppressed* forces rise.†

In the maladies of old age, the dominant condition is the *resolution* of forces; and we must then avoid bleeding, at least generally.

An author's particular position often decides the turn his system takes. Pinel, the timid innovator of our time, was physician to

* "In the whole system of the forces of the vital principle, we must distinguish the forces this principle cause to *act* at each moment in every organ, and the *radical* forces, or the *power* of continuing the natural employment of its *acting* forces."—*Barthez.*

† It is very important to distinguish the state of *resolution* of forces, from the state of simple *oppression*, inasmuch as, in this *oppression*, suitable evacuations often very promptly develop the action of the *radical* forces, which were supposed to be extinguished.

to the old men at the *Salpétrière*, when he made a general rule not to bleed; and Broussais, the daring innovator of our age, was physician to young and vigorous soldiers, at the *Val-de-Grâce*, when he made a general rule always to bleed.

"We must never forget to insist," says M. Reveillé-Parise, "upon this fundamental principle, that the unknown force of life, *vis abdita quædam*, diminishes more and more with the progress of age."

"One physician loses fewer patients than another, because he profoundly understands the senile constitution as a whole, and in its individual modifications.

"Some physicians," he very sensibly adds, "occupy themselves exclusively with the diseases of children; why should not others also devote themselves to those of old age? Have not the latter a peculiar character, which also requires special modification of treatment, and a particular kind of experience?"

"We live on our forces," said Galen.* "As long as our forces are sound, we can resist

* Ex viribus vivimus. "*Method. medend.*," lib. xi. p. 59. (Venetiis, apud Juntas, 1597.)

everything; when they become weak, a trifle injures us."*

And since I am quoting Galen, I must not omit, in a chapter on old age, to remark, that when he speaks of Hippocrates, to represent in one word the man, who, in his eyes, constitutes the most perfect type of a slowly matured wisdom, and most profound experience, he calls him simply *the old man*.†

§ IV. HYGIENIC STUDY OF OLD AGE.

The chapter on *hygiène* will always be the most important chapter in a book on old age, and the article on *longevity* will always be the most interesting article in the chapter.

Hufeland entitles his book simply, "The Art of prolonging Human Life." Cornaro styled his, "On Temperate Life," but he adds, "a certain means to long life." Lastly, M. Reveillé-Parise, defines "Hygiène: the Art of estimating the

* Vires, ubi valentes sunt, omnia contemnunt ac tolerant; ubi infirmæ sunt redditæ, vel absquovis offenduntur. *Method. medend.*, lib. x, p. 63.

† Habet autem *Senis* dictionis series hoc modo. ("*De diffic. resp.*," p. 74.) Et in alio opere recte arbitror à Sene dictum. (*Method. medend.*, lib. xi, p. 71.)

forces of exciting and sustaining them so as to preserve Life as much as possible, as well as possible, and as long as possible."

Let us examine the rules of this precious art. M. Reveillé-Parise shews them to be four :

The first is to know how to be old.

"Few men know how to be old," said La Rochefoucauld.

> "Qui n'a pas l'esprit de son âge,
> De son âge a tous les malheurs."—*Voltaire.*

This first rule is more philosophic than medical, but is perhaps none the less valuable.

The second rule is, to know oneself well ; which is also a philosophical precept applied to medicine.

"Why," says M. Reveillé-Parise, "on this occasion, have philosophy and medicine so much in common ? Because happiness and health are so to speak, one and inseparable."

The third rule is, to properly conform to regular and good habits. It is, in fact, the combination of good physical habits that makes health, as good moral habits make happiness. Old men, who spend one day like another, with the same moderation, the same

appetites, live always. "My miracle is existence," said Voltaire; and if that foolish vanity, which never grows old,* had not induced him, when eighty-four years of age, to make a ridiculous journey to Paris, his miracle would have continued a century, as was the case with Fontenelle.

"Few would believe," said M. Reveillé-Parise, "how far a little health, well managed, may be made to go."

"To use what we have, and to act in everything according to our strength, such is the rule of the sage," said Cicero.†

The fourth rule is, *to attack every malady at its source.* We have already seen, that in youth, life is, as it were, twofold: under the life *of action*, lies another, the life *of power*. In old age, there is only one life; this is the reason why we must cut short at once whatever exhausts this life, *beneath* which no other will be found. These are the four *fundamental rules* (so he calls them) of M. Reveillé-Parise. With these four theoretic rules, and all that may be

* Buffon, see p. 42.

† "De Senectute."

deduced from them in practical advice upon *regimen*, *exercise*, *temperature*, &c., how long will a man live? He will not live more than his life, but he will *live all his life;* that is, all we may venture to expect from the constitution of each *individual*, combined with the general laws of the constitution of the *species*.*

* I cannot conclude this chapter, in which M. Reveillé-Parise has been so frequently quoted, without paying a just tribute to the memory of a man so universally regretted. M. Reveillé-Parise was, at the same time, a physician, a man of letters, a philosopher, and, above all, a philanthropist. Whatever he wrote was sincere and useful. All his works have merited the success he anticipated. "A book," he said, "ought to be a benefit."

CHAPTER III.

ON HUMAN LONGEVITY.

What is the natural, usual, and normal duration of the life of man? This is the question I intend examining in this chapter.

"The man who does not die of accidental causes," says Buffon, "reaches, everywhere, the age of ninety or a hundred years."*

"If we reflect," he adds, "that the European, Negro, Chinese, and American, the civilized man, the savage, the rich, the poor, the dweller in cities, and in the country, differing so much from each other in some respects, all resemble

* Vol. II., p. 76. I must remark that I always quote the same edition of Buffon. The reader will find several notes relating to the subject I have treated in this chapter.

each other in having the same allotment, the same interval of time to pass from birth to death; that the varieties of race, climate, food, conveniences, has nothing to do with the duration of life . . . . we shall discover that the duration of life does not depend upon the habits, customs, nor on the quality of food. Nothing can change the physical laws which regulate the number of our years."*

Buffon is right. The duration of our life depends neither on climate, food, or variety; it depends upon nothing external; it depends only on the internal constitution, and, if I may so express it, upon the intrinsic virtue of our organs.

In the animal economy, everything is subjected to fixed laws.

Every species has its distinct form. The cat and the tiger are two closely allied species, very similar in their whole organization; the cat, however, always preserves its form of cat, and the tiger, its form of tiger.

Each has its determinate period of gestation. In the rabbit species, gestation lasts thirty days;

* Vol. II., p. 76.

in the guinea-pig, sixty days; the cat, fifty-six days; the dog, sixty-four days; the lion, one hundred and eight days. We shall soon see that each species has its particular duration of growth.

If all these things then—form, gestation, growth, &c., have their regular and determinate duration, why should not *life* also have its own.

Buffon is equally correct, when he says that the natural duration of the life of man is from ninety to a hundred years. Every day we see men who live ninety or a hundred years. I well know that the number who reach this term is small, in proportion to those who do not attain it; but some do reach it. And as it is sometimes reached, we may reasonably conclude it would be so oftener, if accidental and extraneous circumstances, and if vexatious *troubles* did not interfere with it.

Most men die of disease, very few die of mere old age. Man has made for himself a sort of artificial life, in which the moral is often worse than the physical; and the physical itself often worse than it would be with habits more serene and calm; more regularly and judiciously exercised. "Man perishes at all ages," says

Buffon, "while animals appear to pass through the period of life with firm and steady pace . . . . The passions, with their attendant evils, exercise great influence upon the health, and derange the principles which sustain us. If we observe men, we shall see that almost all lead a nervous and contentious life, and that most of them die of disappointment."*

We have just seen the opinion of Buffon, let us now proceed to Haller, and add the judgment of the physiologist, to that of the naturalist.

"Man should be placed," says Haller, "amongst the animals that live the longest; how very unjust, then, are our complaints of the brevity of life."†

He first enquires what can be the extreme limit of the life of man; and he gives it as his opinion that man might live not less than two centuries. "Non citra alterum seculum ultimus terminus vitæ humanæ subsistit."‡

As I have before mentioned,§ he collected a

* Vol. II., p. 334.

† Elementa Physiologiæ. Vol. VIII., lib. xxx., p. 95.

‡ Ibid. Vol. VIII., lib. xxx., p. 96.

§ Page 20.

great number of examples of long life. The two extreme examples are those of 152, and of 169 years.

I will stay a moment at the example of one hundred and fifty-two years, because it cannot be disputed: it has the testimony of Harvey.

Thomas Parr was a native of Shropshire. Become famous by his extreme age, Charles the First desired to see him. He went to court, where they feasted him, and eating too much, took a fit of indigestion, and died. Harvey dissected him: all the viscera were perfectly healthy; the cartilages were not ossified, &c. He might have lived many years—he died of an accident.

Haller then asks, what is the natural, that is to say, the regular and normal duration of the life of man. He accumulates facts, and finishes by concluding that it is not easy to decide. "Annos definire," says he, "erit difficilius."*

Haller had read prodigiously; he quotes much, and decides little.

Buffon read but little; he limits himself, in each subject, to two or three authors. In revenge, he takes everything from them. His

* Elementa Physiologiæ. Vol. VIII., lib. xxx., p. 96.

object is to think rather than to instruct: he thinks more than he studies—but he grasps his subject with quickness, decision, and boldness: with the learned Haller, everything becomes more obscure, in proportion as he extends, his reading and erudition.

Haller and Buffon both admit the possibility of long life before the deluge. The fact admitted, Buffon hastens to explain it by a system, Haller limits himself to quoting the systems of Buffon and some others. We are acquainted with the system of Buffon.

Before the deluge, the earth was less solid and compact than it is at present, "because gravity had only been a short time in operation, the earth was less solid, all its productions had less consistency. Man's body, especially, was more pliant, supple, more susceptible of extension; it could then grow a longer time; man arrived at puberty only upon attaining one hundred and thirty years, instead of fourteen. With this, other things are reconciled, for in multiplying these two numbers, one hundred and thirty and fourteen, by the same number, *i. e.*, seven, "we perceive," says Buffon, "that the life of man being now-a-days ninety-eight years, it must

then have been nine hundred and ten years."* It is singular that Buffon here states this view seriously, because he gives it as his own, although he sneered at it in Woodward, from whom he has taken it.

"When we inquire of this author," says Buffon, "how all the earth came to be dissolved, he replies, we must just imagine that, during the deluge, the force of gravity and the coherence of matter suddenly ceased. But, we reply to him, if this attraction of cohesion ceased, why have not the shells been dissolved with the rest? We have only to suppose, (he replies,) that the force of gravity and cohesion did not entirely cease, but that it only diminished sufficiently to disunite all the parts of minerals, but not those of animals."†

About the middle of the last century, at the time we calmly enjoyed all the advantages of civilized life, we were seized with an enthusiastic love of savage life.

Jean-Jacques Rousseau, exclaimed that we ought to throw down the barriers of civilization, and return quickly to the condition of the

* Vol. II., p. 76. † Vol. I., p. 98.

beasts, who only fear pain and hunger.* Diderot and Jean-Jacques Rousseau, said many other things of it. We may at least quote what Buffon said.

"A savage, really a savage, such as the child suckled by the bears, described by Connor; or the youth found in the forests of Hanover, would be a curious spectacle for a philosopher; he could, in observing this savage, estimate the natural appetites at their true value, he would have to discover a soul, and he would distinguish all its natural emotions, and perhaps recognize more gentleness, tranquillity, and peace, than in his own: perhaps, eventually discover that virtue belongs to the savage rather than to the civilized man, and that vice has its birth only in society."†

I have first to observe, that the pretended savages of which Buffon speaks, were simply idiots. Blumenbach has thrown some light on the youth found in the forests of Hanover: he was a deaf and dumb boy, who had been driven from his paternal home by a step-mother.‡

* Discours sur l'inégalité, etc.

† Vol. II., p. 201.

‡ See the author's "Eloge historique de Blumenbach."

The child nursed by bears, spoken of by Connor, the famous author of the "*Médecine Mystique*," had neither reason, speech, nor human voice. Connor's words are: "Neque rationis, neque loquelæ, imo neque vocis humanæ usu gaudebat."* How could Buffon have read the soul of this unhappy child? And then, Connor is such a good authority.

This has not deterred Condillac from reasoning at great length upon the child spoken of by Connor. "A child reared by bears would imitate bears in everything," says Condillac, "would emit cries similar to theirs, and walk on his hands and feet. We are so prone to imitation, that even a Descartes, in his place, would not have attempted to walk on his feet."†

Condillac goes too far. Here imitation has nothing to do with it; the attitude in each species, depends on the conformation only: man naturally walks on his feet, and, in order to walk

* Evangelium Medici, p. 133.

† "I do not advance mere conjectures. In the forests which bound Lithuania and Russia, they found, in 1694, a youth of about ten years, who lived among the bears."—*Essai sur l'Origine des Conn. Hum.*, 1st Part. Sect. IV. Chap. ii.

erect, has no need, thank heaven, of all the intellect of a Descartes.

The savage condition is now perfectly well understood. Independently of the faithful narrations which have come to us from all parts, we have had many savages amongst us. Some of these I have studied.

These poor creatures live entirely naked, without dwellings, fixed habitation, or any other subsistence than that afforded by the chase; when game is abundant they eat much, when it fails they endure hunger gloomily, and with impatience; and it sometimes happens that they eat each other.

I have found in them no other desires than such as were excited by physical wants, no religion, no customs, a stupid but always lively curiosity, habits rather than rules; with family ties not superior to those induced by instinct; maternal love alone is always active, and its gentle influence always respected. "We had rested until noon at the door of the hut," says M. de Chateaubriand, "the sun had become burning hot. One of our hosts advanced towards the little children, and said to them: Children, the sun will burn your heads, go and sleep. They

all cried, 'that is true.' But instead of obeying, they continued their play.

"The women rise . . . . and call their obstinate little troop, by names of endearment. In an instant, the children fly to their mothers like a flock of birds."*

And yet these savages, I speak of the *most perfect savages*, as Buffon says, I mean the *Botecudos*,† men who are without religion, manners, or laws, who appear to have entirely lost the human condition, or more correctly, who seem never to have acquired it; they all appear to have at the bottom of their hearts, a germ of latent faith, and an obscure presentiment of another life, for they believe they will be changed after death, into good or evil spirits, according as they have acted, well or ill, and they do not believe this of animals.

In their admiration for the savage state, they

* Lettre écrite de chez les sauvages de Niagara.

† A young traveller, M. Porte, brought from Brazil two *Botecudos*, a man and woman. He has made some very curious notes upon this colony, but they are far from being complete. M. Porte has returned among the *Botecudos*, and natural history may hope for many valuable observations from this correct and reliable traveller.

did not fail to covet, as may well be supposed, all its advantages, and particularly that most esteemed of all—long life. The truth is, few savages die a natural death; almost all die by accidents, hunger, wounds, the bites of venomous serpents, &c.

I return to the immediate question of human longevity.

This question may be treated in two ways, either historically, as Haller and Buffon have done, or physiologically, and then it becomes an entirely new question. Haller and Buffon sought historically—that is to say, by the enumeration and comparison of facts—what the natural, ordinary, and normal term of the life of man is, and they placed it between ninety and one hundred years. They afterwards sought, still historically, to learn what is the extreme limit of human life, and Haller has placed it at a little less than two centuries.

Thus much for the historical study. Buffon commenced the physiological.

"The total duration of life," he says, "can be measured in some sort, by the period of growth.*

* The judicious Aristotle had already said: "What is related

. . . . "Man increases in height until his sixteenth or eighteenth year, but the development of every part of his body in size is not completed till his thirtieth year. Dogs attain their increase in length, in less than a year, and it is only in the second year that they complete their growth in bulk. Man, who is thirty years growing, lives ninety or a hundred years. The dog, who grows only during two or three years, lives only ten or twelve. It is the same with most other animals."*

Buffon says also: "The duration of life in the horse is, as in every other species of animal, proportioned to the duration of the time of its growth. Man, who is fourteen years growing, can live six or seven times as long, that is, ninety or a hundred years; so the horse, whose growth is completed in four years, can live six or seven times as long, that is to say, twenty-five or thirty years."†

of the longevity of the stag, rests upon no foundation; the duration of gestation, and growth of the young stag, indicates nothing less than a very long life."—*Hist. des Anim.*, Lib. VI., Ch. xxix.

* Vol. II., p. 74.

† Hist. du Cheval.

Finally, Buffon says: "As the stag is five or six years in growing, it also lives seven times five or six years, that is, thirty-five or forty years."*

The real physiological problem is stated. It remains for us to ascertain how many times the duration of growth is comprised in the duration of life. One thing only was unknown to Buffon, namely, the certain sign that marks the term of growth.

I find this sign in the union of the bones with their epiphyses.

As long as the bones are not united to their epiphyses, the animal grows; when once the bones and their epiphyses are united, the animal grows no more.

We have seen, in the preceding chapter,† that in man this union of the bones and the epiphyses is effected at twenty years of age.

In the Camel it takes place at 8 years,

„	Horse	„	„	5	„
„	Ox	„	„	4	„
„	Lion	„	„	4	„
„	Dog	„	„	2	„

* Hist. du Cerf.

† Page 27.

In the Cat, it takes place at 18 months
„ Rabbit „ „ 12 „
„ Guinea-pig „ 7 „

Now man lives ninety or a hundred years, the camel forty, the horse twenty-five, the ox fifteen to twenty, the lion about twenty, the dog ten to twelve, the cat nine to ten, the rabbit eight, the guinea-pig from six to seven years, &c., &c.

The relation pointed out by Buffon is very near the truth. He says that every animal lives nearly six or seven times as long as the term of his growth. The true relation is five, or very nearly.

Man being twenty years growing, lives five times twenty, that is to say, one hundred years. The camel is eight years growing, and lives five times eight, or forty years.* The horse is five years growing, and he lives five times five, that is to say, twenty-five years; and so with the rest.

We have then, finally, a precise characteristic which gives us accurately the duration of

* Aristotle, "Hist. des Anim.," Liv. VI., Chap. XXVI., says fifty years; in Liv. VIII., Chap. IX., he says thirty years.

growth; the duration of growth gives us the duration of life. All the phenomena of life are united by the following chain of relations;—the duration of life is given by the duration of growth; the duration of growth is given by the duration of gestation; the duration of gestation, by the height, &c., &c. The larger the animal, the longer is the time of gestation. The gestation of the rabbit is thirty days; that of man is nine months; that of the elephant is nearly two years,* &c.

We know little or nothing of the duration of life in the elephant. Some writers assert that the elephant lives four hundred or five hundred years. Aristotle says two-hundred;† others say one hundred and thirty, one hundred and forty, and one hundred and fifty. Buffon says, at least two hundred;‡ and M. de Blainville says, one hundred and twenty.§

Thus, upon the duration of life in this animal, which M. de Blainville justly describes as

* It is about twenty months.

† Hist. des Anim., Lib. VIII., Ch. ix.

‡ Ménag. du Mus. Nat., p. 107 (12mo. ed.)

§ Ostéograph. Eléph., p. 74.

the most extraordinary animal in creation,* and of which Buffon has thus nobly spoken: "the elephant is (not including ourselves), the most important creature in the world, he surpasses all terrestial animals in size, he approaches man in intelligence, as much, at least, as matter can approach mind; the earth trembles under his feet, he tears up trees by the roots, with a blow of his body he makes a breach in a wall. Men, at all times, have had a kind of veneration for this great and imposing animal."

With regard to the duration of life in this great, this imposing animal, we are no better informed than were the ancients.

We are equally ignorant, as to what may be the duration of life in the rhinoceros, the hippopotamus, the giraffe, &c. Yet a single exact observation on the period at which the bones unite with the epiphyses in the elephant, the rhinoceros, the hippopotamus, &c., would immediately give us, with certainty, the duration of life in all these large species.

In the "Philosophical Transactions," I find the

* Ostéograph Eléph., p. 88.

history of a young elephant, which died at the age of twenty-eight or thirty years, whose epiphyses were not yet solid; we may be sure, then, from this moment, that the elephant lives five times thirty years, that is to say, more than one hundred and fifty years.

It now only remains to examine whether there is not some general relation, some common measure, by means of which we can determine the extraordinary duration, the extreme limit of life, in the same manner as we have just seen determined its ordinary duration by the duration of growth, and by the union of the epiphyses.

Haller quotes two examples of extreme life, one of one hundred and fifty-two years, the other of one hundred and sixty-nine; and it is upon these facts, that he establishes his belief, that man, when his life is prolonged to the extreme limit, scarcely lives less than two centuries.

Buffon relates, with much minuteness, the history of a horse that lived fifty years; and this little history is full of curious details. The Duke Saint Simon, sold, in 1734, to the Bishop of Metz, a horse, aged ten years. The

Bishop of Metz, (Saint Simon,) dying in 1760, his successor kept the horse, and worked him, without taking much care of him, till 1766. They saw then that the horse required to be cared for; they worked him less, certainly, yet the animal was never allowed to be idle. A smaller cart than usual was made for him, which he drew about from morning till night; shortly after he could only draw it a few hours a day. Finally, on the 24th February, 1774, at the moment he was about to begin his work, he fell down at the first step, and died.

"Here," says Buffon, "we see in the horse species, the instance of an individual living fifty years; that is, double the ordinary life of these animals; thus, analogy generally confirms what we learn from particular facts; that we may find in every species, and, consequently, in the human species as well as in that of the horse, some individuals in whom life is prolonged to double that of ordinary life, that is, to one hundred and sixty years, instead of eighty. These privileges of nature are, it is true, placed at long intervals of time, and at great distances in space; they are the prizes in the lottery of life; nevertheless, they suffice to give to old

men, even the oldest, the hope of a still greater age."*

These reflections appear to me very just, the more so as it is easy to add many facts similar to that cited by Buffon.

The camel usually lives from forty to fifty years, but it may live, as Aristotle says, a hundred.† The lion generally lives twenty years, but it may live forty and even sixty years. "Leonem vidi," says Haller, "quadragenarium, qui sexagesimo anno obiit."‡ I find many instances of dogs having lived twenty, twenty-three and twenty-four years; and some cases of cats having lived eighteen or twenty, &c.

I know nothing certain of the duration of life in birds.

"Hesiod," says Pliny, "attributes to the rook nine times our life; to the stag four times the life of the rook; and three times the life of the stag to the raven. Hesiodus.... cornici novem nostras attribuit ætates, quadruplum ejus cervis, id triplicatum corvis."§

* Vol. II., p. 237.

† Hist. des Anim., Liv. VIII., Ch. ix.

‡ Elem. Physiol., Vol. VIII., Lib. xxx., p. 93.

§ Pliny, Lib. VII., Cap. xlviii.

Buffon thus remarks upon this passage in Pliny: "In taking the age of man at only thirty years, this will give nine times thirty, or two hundred and seventy years for the rook, one thousand and eighty for the stag, and three thousand two hundred and forty for the raven. In reducing the life of man to ten years, this will give ninety years for the rook, three hundred and sixty for the stag, and one thousand and eighty for the raven, which is still extravagant. The only way of giving a rational meaning to this passage, is to render the γενεά of Hesiod, and the *ætas* of Pliny by year; then the life of the rook is diminished to nine years, that of the stag to thirty-six, and that of the raven to one hundred and eight, as is proved by observation."*

Buffon is quite at liberty to comment upon Hesiod and Pliny as he pleases but he ought, at least, to tell us upon what facts he has founded his assertion, that the hundred and eight years of the raven are *proved by observation.*

Fontenelle quietly narrates (for in this matter, he had almost the right not to be astonished at

* Histoire du Corbeau.

anything,) the history of a parroquet that lived, he says, nearly a hundred and twenty years. This parroquet was brought to Florence in 1633, by the Grand-Duchess de la Rovère d'Urbino, when she came to marry the Grand-Duke Ferdinand, and the princess said then that this parroquet was the oldest member of her family; it lived at Florence nearly a hundred years.

"When we give to it, on the faith of the words of the Grand-Duchess," said Fontenelle, "about twenty years, it will then have lived a hundred and twenty years. This is, perhaps, not the longest term of life for these animals; but it is at least certain, from this example, that they can attain it."*

"The swan has the advantage," said Buffon, "of enjoying to an extremely advanced age its quiet and charming existence. Every observer accords to it a very long life; some even, have gone so far as to say three hundred years, which is doubtless an exaggeration; but Willoughby, having seen a goose, which, upon sure evidence, had lived a hundred years, did not hesitate to

* Histoire de l'Académie des Sciences, ann. 1747, p. 57.

conclude from this case, that the life of the swan may and ought to be longer, both because it is larger, and because it takes longer time to hatch its eggs; incubation in birds corresponding to the time of gestation in animals, and, perhaps, having some relation to the time of growth of the body, which is proportionate to the duration of life. The swan is more than two years in growing, and this is a long time, for in birds the entire development of the body is much quicker than in quadrupeds."*

Willoughby infers, then, the long life of the swan from that of the goose, which could be proved to have lived a hundred years. This *certain proof* of a hundred years, in the case of the goose, reminds us of the hundred and eighty years for the raven, *proved by observation*, which Buffon speaks of.†

We know, vaguely, that fish live a very long time. We might conclude so from the softness of the skeleton alone. As to exact observations and precise facts, there are none.

"I have seen," says Buffon, "some carp,

* Histoire du Cygne.

† See p. 52.

in the ponds of M. le Comte de Maurepas, at Pontchartrain, which are well proved to be, at least, one hundred and fifty years old; and they appeared to me as lively and active as the younger ones."*

Duhamel, who wrote some years after Buffon, contents himself with saying, "the carp in the ponds at Pontchartrain, which are the largest and oldest I know of, are certainly more than a hundred years old."† Here is always a century *proved* to quote Buffon. The centenary life of an animal, so small as a carp, is certainly a very remarkable physiological fact.

We perceive how new all this material is, although so full of interest. We should ascertain in birds, fishes, and reptiles, what is the proportionate duration between the growth and the whole life. And, very probably, we would find that it differs a little from the proportion found to exist among the mammiferous animals. I am confining myself to the class mammifera; it is the only one that embraces the studies

* Vol. I., p. 593.

† Traité des Pêches. Partie II., p. 35.

I began with, it is also the most akin to man.

It is a fact, a law, that is to say, from general experience in this class, that extraordinary life can be prolonged to double* that of ordinary life.

Just as the duration of growth, multiplied a certain number of times—say five times—gives the ordinary duration of life, so does this ordinary duration, multiplied a certain number of times—say twice—give the extreme duration.

A first century of ordinary life, and almost a second century, half a century (at least) of extraordinary life, is then the prospect science holds out to man. It is quite true, to speak like the ancients, that science offers us great store of life, more in power than in act, "plus in posse, quam in actu;" but were it given to us to offer it in act, would the complaints of man cease?

"Begin by teaching me," said Micromegas, "how many senses the men in your globe have?" "We have seventy-two," replied the

* Buffon. See page 62.

inhabitant of Saturn, "and we complain every day of the few."

"I believe it," replied Micromegas, "for in our globe, we have nearly a thousand, yet there still remains vague desire for more."

PART II.

ON THE AMOUNT OF LIFE UPON THE GLOBE.

CHAPTER I.

BUFFON was the first to start the interesting subject, of the amount of life upon the globe.

"Taking beings generally," says Buffon, "the total quantity of life is always the same, and death, which seems to destroy everything, destroys nothing of that primary life common to every species of organized beings; like all other subordinate and inferior powers, death attacks only individuals, only strikes the surface, destroys only the form, can effect nothing upon

matter, and does no harm to nature which only shines the brighter, and does not permit death to destroy the species, but allows it to cut down individuals, and destroy them with time, to shew itself independent of death and time, to exercise at every moment its ever active power, to manifest its plenitude by its fecundity, and to make of the universe a theatre always full, a spectacle ever new, by the perpetual reproduction of beings."

"God," he continues, "in creating the first individuals of each species of animals and plants, has not only given form to the dust of the earth, but also rendered it living and animated by enclosing in each individual a larger or smaller quantity of active principles, of living organic molecules, indestructible and common to all organized beings; these molecules pass from body to body, and serve equally for actual life and for the continuance of life, for nutrition, and for the growth of each individual; and after the dissolution of the body, after its destruction, its reduction to ashes, these organic molecules, upon which death has no influence, survive, circulate in the universe, pass into other beings, and bring them nourishment and life: every pro-

duction, every renewal, every increase by generation, by nutrition, by developement, supposes, consequently, a preceding destruction, a conversion of substance, a transference of these organic molecules which, not multiplying, subsist always in equal number, rendering nature always equally living, the world equally peopled, and always equally resplendent with the glory of Him who created it."

I must quickly leave the field of these bold speculations to Buffon. I cannot admit his common source of life; it is by metempsychosis alone, that souls pass from one being to another; these organic molecules, like the monads of Leibnitz, are only one of those philosophical expedients which are imagined, to fill up a blank in theory; and, moreover, Leibnitz makes the monads very indestructible, but not common and convertible.

In the midst of these extended views of Buffon, more compromised than helped by the aid of hypothesis, I seek for the true idea, for there is one, which forms the solid basis of such lofty eloquence. I do not study life either in organic molecules, or in monads; I study life in

* Histoire du Bœuf.

living beings: and I find two things, first, that the number of species has continually diminished since animals appeared on the globe; and, second, that the number of individuals in certain species, tends, on the contrary, always to increase; so that, in the main, everything properly considered, the total amount of life, I mean the total quantity of living beings, always remains, as Buffon says, nearly the same.

In the first place, I say, that the number of species tends always to diminish, and of this successive disappearance of species, of this extinction, we have positive examples, even in our own historical times.

The *dodo* no longer exists. When in 1545, the Portuguese discovered the Isles of France and Bourbon, they found there a large bird, heavy, indolent, and, as Buffon said, "in whose composition the living molecules seemed too scanty." This great bird, which could neither run nor fly, and its flesh having a disagreeable taste, was soon exterminated by the sailors. The entire species has been destroyed. Of the *dodo*, there now only remains a foot, preserved in the British Museum, and a head, in the Ashmolean Museum at Oxford.

Upon these remains, which are in a very bad condition, the sagacity of our Owen has been exercised. Cuvier considers the dodo a penguin, Temminck regards it as a *manchot* (booby), and de Blainville, a vulture.

But the dodo is not, by any means, the only species which has disappeared within historical times. In a certain sense, I reckon as so many lost species, the primitive stocks of most of our domestic animals. These primitive stocks no longer exist.

Europe formerly had two kinds of *oxen*, the *aurochs* and the *thur*. The aurochs still exists, the thur is extinct.

Buffon has occupied himself largely with this curious point in the primitive races of the oxen of Europe. He first finds an affinity between the *bison* of the ancients and the *aurochs*, and so far all is well; but he next endeavours to find in this same *aurochs* the stock of our domestic ox, and here deceives himself.

Cuvier has satisfactorily proved that the domestic *ox* does not come from the *aurochs*. The *aurochs* has a mane and a beard, which our ox has not; he has a pair more of

ribs,* which is still more notable and decisive, and the horns of the *aurochs* are attached below the occipital crest, whilst those of the ox are attached above it.† Our *ox* comes from the *thur*,‡ an animal seen and described in the

* The *aurochs* has fourteen pairs of ribs, the ox has only thirteen.

† "The forehead of the ox is flat and even a little concave, that of the aurochs rises, although a little less so than in the buffalo. The forehead in the ox is squarer also, its breadth being about equal to its height, taking its base between the sockets; measuring it in the same manner in the aurochs, the breadth is greater than the height, as three is to two. In the ox, the horns are attached to the extremities of the most elevated salient line of the head, that which separates the occiput from the forehead; in the aurochs, this line is two inches further back than the root of the horns; in the ox, the plane of the occiput makes an acute angle with the forehead; this angle is obtuse in the aurochs; lastly, this plane of the occiput, which is quadrangular in the ox, describes a semi-circle in the aurochs."—*Cuvier, Rech. sur les Oss. Foss.* Vol. VI., p. 220. Ed. 1834.

‡ It is my opinion, that in the time of Herberstein, the *thur* was a real and distinct animal, which has since perished, as, according to all Prussian and Polish writers, the aurochs is now threatened with coming destruction. Consequently, if, as we cannot doubt, continental Europe has really possessed a *urus* and a *thur*, differing from the bison or the aurochs of the Germans, it is only in its remains that traces of this species can now be found. Now this trace is really found in the skulls of a species of ox differing from the aurochs, buried beneath the superficial soil of certain cantons.

sixteenth century by Herberstein,* but which no longer exists.†

The primitive stock of the *horse* exists no longer; nor does that of the ox. The wild *horse*, which lives in troops, frequently very numerous, amid the plains of Asia and America, is only the old domestic *horse* set at liberty.

The stock of the *camel* and the *dromedary* is lost, as also that of the *dog*. Some naturalists derive the dog from the wolf; others, from the fox or the jackal, and even from the hyena. Pallas says it comes from all these animals together; from the wolf comes the sheep-dog; from the fox, the dogs

This must be the true *urus* of the ancients, the original of our domestic ox, while the aurochs of the present day is only the bison or bonassus of the ancients, a species which has never yet been subjected to the yoke, as has already been stated."—*Cuvier, Rech. sur les Oss. Foss.* Vol. VI., pp. 233 and 235.

* Rerum Moscovitarum, Commentarii, etc. 1566.

† The skulls of the *thur*, studied by M. Cuvier, were found in the turf-pits of the north of France. "All the characters I have assigned to the ox species, are met with," says he, "in these skulls, and I do not doubt but that they have belonged to a wild race, very different from the aurochs, and which was the true stock of our domestic ox, a race most likely destroyed by civilization, as those of the camel and dromedary now are." *Rech. sur les Oss. Foss.*, Vol. VI., p. 309.

with pointed muzzles; from the hyena comes the mastiff, &c.

I am satisfied, from long continued experiments, that none of these theories are well founded. The *hyena* and the *dog* do not breed together, nor do the *dog* and the *fox*; the *dog* breeds with the *wolf*, but only produces *mongrels*, sterile in the third generation; with the *jackal*, it produces *mongrels*, sterile in the fourth generation.

The *dog* comes then, neither from the *wolf*, nor the *fox*, nor the *hyena*; the *dog* comes from a stock of its own, and this stock is entirely lost.

Here, then, are several animals: the *ox*, the *horse*, the *camel*, the *dromedary*, the *dog*, &c., whose stock, whose race, as Cuvier says, is destroyed,* and yet we are still only in historical times.

If we pass from these historical times, to those anterior to all history, to all man's recollection, it will no longer be by units, but by thousands, that we must reckon the species lost and destroyed.

* See note ‡ of page 82.

The present period has but one gigantic quadruped, the *elephant*, for I can only put in a lower and secondary rank, the *rhinoceros* and the *hippopotamus*.

The past epoch, had the *mammoth*, the *mastodon*, the *dinotherium*, the *megatherium*, &c. All these gigantic species have disappeared.

The history of the *mammoth*, or fossil elephant, whose bones abound in Siberia, and whose ivory constitutes an important and inexhaustible article of the commerce of that country, is well known. The imagination of the Russians has made of the mammoth a fabulous monster, with two horns placed above its eyes, and which makes itself large or small, at pleasure, lives under the earth, and perishes as soon as it sees daylight.

In Europe, the bones of the *mammoth* were taken for those of giants, and what is yet more strange, for freaks of nature. "They discovered," says Cuvier, "at Tonna, in the duchy of Gotha, in 1696, some elephant's bones; a femur, a humerus, some ribs, vertebræ, and molar teeth. The learned of the country, consulted by the Duke of Gotha, unanimously

declared that these objects were *freaks of nature*, and maintained this opinion in several publications."*

The *mammoth* has left some of its bones everywhere: in America, in Asia, in Europe, in France, where, at Paris, not long ago, was found the remains of a skeleton.†

Our epoch has seen not only the bones of a mammoth; but the animal entire, with its flesh, skin, hair, &c.

"In 1799," says Cuvier, "a Tongouse fisherman observed on the shores of the Arctic Ocean, near the mouth of the Lena among blocks of ice, a shapeless mass, which he could not make out. The following year, he perceived that this mass was a little more loosened, but he could not yet guess what it was. Towards the end of the following summer, the entire flank of the animal, and one of its tusks,

* Rech. sur les Oss. Foss., Vol. II., p. 84.

† These remains, which were found in a piece of land belonging to the Hôpital Necker (Rue de Sèvres) consisted of two molars with straight and parallel edges, of a portion of a rather delicate tusk, and the upper portion of the tibia. The whole was buried in the alluvial sand of the left bank of the Seine, fourteen feet deep. See the *Comptes Rendus* of the Acad. des Sciences. 1838. Pages 1027 and 1051.

were quite freed from the ice. It was not till the fifth year, that this enormous mass came ashore on a sand-bank. In the month of March, 1804, the fisherman removed the tusks, and sold them for fifty roubles, &c." I abridge the surprising account. When, in 1806, M. Adams, member of the Academy of St. Petersburg, saw this animal, the remains of an extinct race so singularly preserved, he found it much mutilated. "The Iakoutes of the neighbourhood had removed the flesh to feed their dogs with; some wild animals had also fed upon it, but the skeleton was found still entire, with the exception of a fore-foot. The vertebræ, a shoulder-blade, the pelvis, and the remains of these extremities, were still united by the ligaments, and a portion of the skin. The head was covered with a dry skin, and one of the ears, well preserved, was furnished with a tuft of hair; the pupil of the eye could also be distinguished. The brain was found in the cranium, but dried up; the neck was furnished with long hair; the skin was covered with black hair, and with a reddish wool; what remained was so heavy, that six persons had much difficulty in carrying it. According to M. Adams, he

collected more than thirty pounds weight of hair and wool, which the white bears had trodden into the humid soil, while devouring the flesh."*

All this narrative is full of interest; but I must call particular attention to the fact, that this *mammoth* was covered with hair and wool, because it has greatly influenced the opinions of M. Cuvier.

In his "Discours sur les Révolutions du Globe," referring to large quadrupeds† preserved entire in the ice, with their flesh and skin, he says: "Had they not been frozen as soon as killed, they would have become decomposed by putrefaction; and on the other hand, this perpetual frost did not previously occupy the places

* *Rech. sur les Oss. Foss.* Vol. II. p. 131.

† This *mammoth* is the *fossil rhinoceros*, discovered in 1771 on the borders of the Wiluji. "Pallas published in 1773 the astonishing discovery of an *entire rhinoceros*, found, with its skin, in December 1771, buried in the sand, on the banks of the Wiluji, a river which falls into the Lena, below Iakoutsk." (Cuvier, *Rech. sur les Oss. Foss.*, Vol. III., p. 87.) This *rhinoceros* was also covered with hair. Pallas himself saw in the month of March, 1772, the skull and the feet covered with skin, ligaments, tendons, and the largest fibres of the stiffened flesh. See *Novi Commentarii Acad. sci. imp. Petrop.* 1773.

where they have been overwhelmed, for they could not have lived under such a temperature; the same hour that witnessed their death, saw the country they inhabited become glacial."

He afterwards says: "I do not think there has been a change of climate. The *elephant* and *rhinoceros** of Siberia were covered with thick hair, and could bear as severe cold as the *bears* and *argals;* and the forests with which this country is covered even to very high latitudes, furnished them with more than sufficient nourishment."†

* See note † page 88.

† *Rech. sur les Oss. Foss.*, Vol. II., p. 245. This circumstance, of an elephant covered with hair, has also much struck M. de Laplace. "Every hypothesis founded upon a considerable displacement of the poles on the surface of the earth, must," he says, "be rejected. This displacement must have been imagined in order to explain the existence of elephants, of which the fossil bones have been found in such great abundance, in northern climates where elephants could not now exist. But an elephant, which we have reason to suppose contemporary with the deluge, having been found in a mass of ice, its flesh well-preserved and its skin covered with a great quantity of hair, has proved that this species of elephant was protected from the cold of northern climates which it could inhabit and even seek. The discovery of this animal, has then confirmed what the mathematical theory of the earth teaches: that in the revo-

I resume my enumeration of lost species. By the side of the *mammoth,* we must place the *mastodon.*

In 1739, a French officer, M. de Longueil, exploring the Ohio, some men in his troop found an enormous tooth, and certainly the largest of all animal teeth that they had ever seen. On his return to Europe, M. de Longueil carried it to Buffon, and it was at the sight of this tooth that Buffon conceived the great idea of *extinct races.* "Everything tends to the belief," says Buffon, "that this ancient species (the species revealed by the tooth), which we must regard as the chiefest and largest of all terrestrial animals, has only existed in the earliest ages, and has not descended to our times."*

lutions which have changed the surface of the earth, and destroyed many species of animals, the figure of the terrestrial spheroid, and the position of its axis of rotation upon its surface, have undergone only slight modifications." (*Exposition du système du monde.* Vol. II., p. 138, 5th edition.)

* *Epoques de la Nature: Notes justificatives.* Note 9. "What is very remarkable," he says again, "is that not only have they found real tusks of an elephant, and real teeth of the great hippopotamus in Siberia and Canada, but they have found teeth much more enormous with great flat edges, &c. I believe then we may pronounce with certainty that this great species of animal is lost."—*Ibid.*

From the *mastodon* I pass to the *dinotherium*. The discovery of the *dinotherium* is of very recent date. In 1829, M. Kaup found at Eppelsheim, in the grand duchy of Hesse-Darmstadt, a lower jaw, armed with two enormous tusks, curved downwards. In 1836, M. Klipstein found the remainder of the head of the animal, unknown till then, and to which the tusks of the jaw had once belonged. This strange animal was named *dinotherium*.

It exceeded the largest elephant in size, and like the elephant and mastodon, it had a trunk, and two tusks; but these tusks were attached to the lower jaw, and curved downwards, while the tusks of the elephant and the mastodon are attached to the upper jaw, and curved upwards.

The fourth gigantic animal of ancient times, the *megatherium*, had no trunk like the *elephant*, *dinotherium*, and *mastodon*: it was an edentate quadruped, but a quadruped of the size of the largest *rhinoceros*—an animal as large as a *rhinoceros* in such degree, were existing animals, I am speaking of the largest, are not so big as a dog.

I have named only a single fossil elephant;

but it is supposed that many may exist. I have named only one mastodon, the *great mastodon*, but there are many others, and the *mastodon* with narrow teeth is but little smaller. There are several *dinotheriums*. The *megalonyx*, that monstruous *edentate*, first made known by Jefferson, was but little smaller than the *megatherium*. This world of lost species had more *rhinoceroses* than we have. It had more hippopotami, &c.; and besides all the species which we have not, it had all ours, or at least their *analogies*.

It had the *analogies* of our elephant, of our rhinoceros, of our hippopotamus; it had the analogies of all our *carnivora*—lions, tigers, hyenas, &c.; of all our ruminants—giraffes, stags, and antelopes; of all our *rodents*, from the beaver to the rabbit, &c.; of all our *pachyderms*, from the elephant, which I have just named, to the wild-boar; and how many more which we have no longer, the *palæotherium*, the *anoplotherium*, the *lophiodon*, the *anthracotherium*, &c.; it had also the *analogies* of our *quadrumana*—more than one *fossil* ape has been found. Man is the only one of all animated beings that this world of *lost species* has not yet presented to us.

To come to some more definite examples, we can reckon nearly forty species of *pachyderms* which have formerly lived on the soil of France; the *elephant*, the *dinotherium*, the *mastodon*, the *palæotherium*, &c., &c. Of all these *pachyderms*, only one remains, the *wild-boar*. We can reckon nearly a hundred species of *ruminants*, which occupy the soil that we now dwell upon. Of these only three remain —the *ox*, the *stag*, and the *deer*.*

The class of *reptiles* has long ago lost all its great species, the *ichthyosaurus*, the *plesiosaurus*, the *megalosaurus*, the *mosasaurus*, &c., &c. M. Agassiz, who has made so many researches, and discovered so much in regard to *species* no longer extant, reckons in the single class of *fishes*, 25,000 fossil species; that is, as many as 25,000 lost species—*now*, we do not know more than five or six thousand species of living fishes.—He counts as many as 40,000 fossil shells, &c., &c.

I have just remarked that the epoch of *lost species* had more *rhinoceroses* and *hippo-*

* See a very interesting note, by M. P. Gervais, in the *Comptes rendus de l'Académie des Sciences.* Vol. II. p. 552.

potami than we have now; we have only one *hippopotamus;* it had as many as three or four. We have only four or five species of *rhinoceros;* and some naturalists believe they can count more than fifteen or twenty fossil species.

Among all these *fossil rhinoceroses*, is one, particularly remarkable, the *rhinoceros tichorhinus* of Cuvier. The partition of its nose was osseous. It was a rhinoceros of this species which was discovered in 1771 near Wiluji, entire, with its skin, flesh, and hair, for it was also covered with hair like the *mammoth.*

We may now repeat the common opinion, "that nature disdains individuals, but preserves species with extreme care!" Nature disdains species no less than individuals; she takes no more account of one than of the other; each species disappears in its turn, the greatest as well as the least. Among the *fossil* species, we find animals larger than the *elephant*, and smaller than the *mouse* or *shrew-mouse. Nature* is only a word.

God in creating a being which *could know itself, and Him also*, has thus given a master

to all other living creatures. "Man *thinks*," said Buffon; "hence he is master over beings which do not think."*

Cast naked and helpless upon the surface of the globe, Man, by his intelligence, has become the best armed, and the most terrible of all created beings. He discovered fire; with fire he prepared iron; he has fought with, and banished far from him, every animal that could injure him; he has collected those about him which are most necessary to his wants. After discovering fire, he invented agriculture; possessing the earth, he was assured of a subsistence, not for one day, or for a few days, but for years, for all time. Hence he has been able to occupy and elevate himself by the culture of his mind.

Hence he has also been able to see his species develope, increase, and diffuse itself everywhere, and wherever it has appeared, he soon sees it dominate over others. However little we dig up the soil of this we dwell upon, we find the remains of *elephants*, *rhinoceroses*, *palæotheriums*, &c. And these remains astonish

* Vol. II., p. 367.

us no less by their quantity than by their form; but, only for a moment, calculate the immense number of men that, during the centuries Paris has existed, have accumulated on this little spot of earth: a single species would perhaps have given more *individuals*, more *living beings* than every other species which has successively lived upon it, before in its turn, it has come to take their place.

And since, on the one hand, by destroying the noxious species, man has multiplied, so on the other, he has multiplied almost to infinity all the useful animals. Thus he has augmented the *quantity of life* on the earth. "Man," says Buffon, "has made choice of some twenty species of birds and mammals, and these twenty species alone figure more largely in nature, and are of more advantage to the world than all the others put together. They figure more largely, because they are directed by man, who has multiplied them prodigiously. In concert with him, they effect all the good that can be expected from a wise exercise of strength and power for the cultivation of the earth, the transport and commerce of its productions, the augmentation of subsistence—in a word, for

all the wants and even the pleasures of the only master who can repay their services by his care."*

I have said that man was cast naked and feeble upon the earth. I ought to add, that he was cast upon it with the most unfavourable *natural régime.*

A question that has much occupied the attention of physiologists, and which they have not decided, is, what could have been the *natural food*—the *primitive diet* of man. According to some, it is *herbivorous;* according to others, man has always been what we now see him: that is, at once *herbivorous*, and *carnivorous*, or *omnivorous.*

By comparative anatomy, we very well understand the condition of the herbivorous and of the carnivorous diet; and it is easy to perceive that man, primitively, has been neither *herbivorous* (at least, essentially *herbivorous*) nor *carnivorous.*

The carnivorous animal has sharp molar teeth, a simple stomach and short intestines.

* *Epochs of Nature.* Seventh Epoch.

The *lion*, for example, has all its molar teeth cutting, a small straight stomach, almost a canal, and intestines so short that they are only three times the length of the body.

Man has no sharp molar teeth; his stomach is simple but large, and his intestines are seven or eight times the length of his body. Man, therefore, is not naturally *carnivorous*. In every animal, the form of the molar teeth indicates the food. The *lion*, which has only sharp molars, lives exclusively on prey, and even living prey; the *dog*, which has two tuberculous molars, that is, with blunt point, is able to mix vegetables with his food; the *bear* has all its teeth tuberculous, and can live entirely on vegetables.*

Man, then, is not *carnivorous*, neither is he essentially *herbivorous*. He does not possess, for example, like the *ruminating* animal, (the *herbivorous* animal, *par excellence*), molar teeth with crowns alternately hollow and raised, a

* A bear which I have fed nearly five years upon brown bread and carrots, has now no longer any desire to touch flesh.

stomach which is composed of four stomachs, and intestines even twenty-eight and forty-eight times longer than its body. The intestines of the *sheep* are twenty-eight times longer than its body; those of the *buffalo*, thirty-two; those of the *ox*, forty-eight, &c.

By his stomach, teeth, and intestines, man is naturally and primitively *frugivorous* like the *ape*.

But the frugivorous diet is, of all others, the most unfavourable, because it constrains animals, subjected to it, never to quit the country where fruit is constantly found, that is, the warm countries. All the *apes* inhabit warm countries.

But man, when he had once discovered fire, when he had once prepared and made tender, by cooking, animal as well as vegetable substances, was able to feed upon all living creatures, and mix together every diet.

Man, therefore, has two diets: one natural, primitive, *instinctive*,—by which he is *frugivorous*; and he has an *artificial* diet, due entirely to his intelligence, by which he becomes *omnivorous*.

But to return to the principal subject of this article. We have seen that, relatively to the *quantity of life*, there is a kind of compensation upon the globe,—in proportion as certain species die out, the number of individuals in some others, increases; but is the compensation absolute, as Buffon assumes? This we shall not attempt to examine. We certainly think so. It is easier to pronounce an opinion upon questions of this sort, when we calculate with *organic molecules*, than when we do so with *living beings*.

One thing, at least, is evident; viz., that in proportion as the globe—which has not always been in a condition suitable to the manifestation of life—became modified, and, if I may use the expression, accommodated itself more and more to this manifestation, a very sensible variation is effected in the relative proportions of the species. In the first ages of the globe, it is the lower species—the lowest species—which predominate. In the subsequent ages, it is the gigantic and formidable species, both among reptiles and quadrupeds; in the present era, it is the animals protected by man, and man him-

self—upon whom all superiority on this globe, even that of number,* seems ulteriorly devolved.

* "The number of mankind has become a thousand times greater than that of any other species of powerful animals." —*Buffon.*

CHAPTER II.

FIXITY OF THE EXTERNAL FORMS OF LIFE, OR OF THE SPECIES.

We have seen in the preceding chapter, that a multitude of species has already disappeared from the surface of the globe. Species disappear, that is certain; but it is no less certain, that, so long as they exist, they remain the same. Species are unchangeable. Here, then, we have two facts: species disappear; and species are fixed.

I am well aware that, in all times, certain naturalists and writers have maintained that species change. But who among them ever saw a species change? During the two or three thousand years that men have observed and

written, has a single species ever changed, or been transformed into another? We confidently answer—No!

As I treat my subject very gravely, I shall not quote Maillet, who pretends that we have all commenced by being *fishes;* this idea excited the risibility of Voltaire. I shall not quote Robinet, who uses literally the words of Pliny: —"That the convolvulus is the prentice-work of nature, who attempted to make a lily." *Convolvulus tirocinium naturæ lilium formare discentis.* I shall not even quote M. de Lamarck, who would have it, that all animals have begun by being *polypi* or *monads.*

I at once enter upon the subject; and commence by separating what concerns *species,* from what I shall have to say on *varieties.*

SECTION I.—OF SPECIES.

In the change of species, I see only three kinds of causes: either *slow causes,* or *sudden* and *violent causes,* or the *crossing of species.*

1. *Of slow causes.* I call slow causes

those which act at every moment without interruption, without rest, and which adding every day one little alteration to another, effect at length, great results.

It is by a similar insensible progress that every physical change in the course of ages is produced. The continuity of the motion conceals its progress. We do not see, and we take no note of the increase of parts; and yet they grow. We do not see, we do not note the change in their relative proportions; and yet at the end of several years, these proportions have changed, and so changed, that in more than one case, it is difficult to recognise the *individual*, and even the *species*.

It required all the sagacity, the profound sagacity of Cuvier, to recognise in the young *ourang-outang*, the adult, the enormous *pongo*. Until lately, two species were made of the *mandrill* and *chorax*, the young *mandrill* and the adult *mandrill*.

Buffon made three species of the *pithek*, the *little cynocephalis* and the *baboon*. The *pithek* is the young *baboon*, the *little cynocephalis*, the *baboon* at middle age, and the *baboon* is the mature animal, &c.

We are familiar with the metamorphosis of insects. Who, if the phenomenon were not so familiar, would recognise the *fly* in the *flesh-maggot ?* or this same *maggot* as a *chrysalis ?* Certainly no one.

"No one," said Cuvier, "would imagine, if he had not remarked it, or been told, that a caterpillar would become a butterfly."*

The young frog has a tail, has no feet, and breathes through gills; the adult frog has feet, no tail, and breathes by lungs. By such differences, two ordinary animals would be made animals differing not only in *species*, but, in *genus*, *family*, *order*, and even *class*.

How is it then, if these species have a tendency to transmutation—to pass from one to another, that time, which solves all things, has not finished by betraying, by revealing this tendency ?

But it may be said, that *time* is wanting. It is not wanting !

Two thousand years have elapsed, since Aristotle wrote; yet we recognise, at the present day, all the animals he has described; and we also

* *Règne animal.* Vol. I., p. 38.

recognise them in the characters he has assigned to them. Cuvier could well write this sentence, so applicable at the present moment: "The history of the elephant is more correct in Aristotle than in Buffon."

From Egypt are brought the remains of animals, which lived two or three thousand years ago: the *ox*, *crocodile*, *ibis*, &c.; they do not differ, in any respect, from those now living. We have *human mummies* before us. The skeleton of the man of the present day is the same—absolutely identical—with the skeleton of the ancient Egyptian.

Thus, since two or three thousand years, since the observations of Aristotle, since the date of the *mummies* preserved in Egypt, no species has changed. An experiment, which lasts two or three thousand years, is no longer an experiment to be made—it is made; species do not change.

By dint of combination, valuation, and study, naturalists have succeeded in referring the almost infinite variety of the forms of animals, to a few leading and principal ones. To arrive at this, has been the great object of every naturalist,

from Aristotle to Cuvier; and these two, particularly, have occupied themselves with classification and *method.*

Aristotle arranged all the forms of animals under nine principal groups:—*birds*, *fishes*, *cetacea*, *viviparous quadrupeds*, *oviparous quadrupeds*, *testacea*, *crustacea*, *mollusca*, and *insects*. Of these nine general and principal forms, none have changed. The *birds*, *quadrupeds*, *fishes*, *insects*, &c., of the present day, are like those of his own time.

Having mentioned the classification of Aristotle,* I remark, *en passant*, how very superior

* Here is the complete quotation. Aristotle first divides the entire animal kingdom into two great divisions: one of animals having blood, the other of those having none; that is, the division of animals with red blood, and that of those with white blood. Aristotle very well understood that no animal is deficient in blood. "It must be remarked," says he, "that all animals, without exception, have a fluid, the privation of which, either naturally or accidentally, causes them to perish." And he calls by a very proper term, a kind of *lymph*, the fluid of animals with white blood. He then subdivides the red-blooded animals into five classes: *viviparous quadrupeds*, *cetacea*, *birds*, *oviparous quadrupeds*, and *fishes;* and the white-blooded animals into four: *mollusca*, *testacea*, *crustacea*, and *insects*.

to that of Linnæus, which is scarcely more than a century old.

Linnæus divided the animal kingdom into six classes :—*mammiferæ*, *birds*, *reptiles*, *fishes*, *insects*, *worms*.

He well named *mammifera*, the *viviporous quadrupeds ;* for all the *mammifera* have not four feet, for example, the *cetacea*, which have only two ; the *apes*, which have four hands and no feet, &c. He well named reptiles, the *oviparous quadrupeds*, which all crawl, and have not all four limbs ; for example, *serpents*, which have none at all,* &c. But he mixes the *cetacea* with the *fishes*, the *bat* with the *birds* ; and in his class, *worms*, he places and confounds the *crustacea* with *testacea*, *mollusca*, &c.

Aristotle has committed none of these errors. He knew very well that the *cetacea* are not *fishes*, that they are viviparous, that they have mammæ,† suckle their young, are covered with

* This did not deceive Aristotle. "The serpents," says he, "may be put beside the lizard. They resemble them in almost every thing, supposing the lizard to be longer, and its feet cut off."—*Hist. des anim.*

† "The dolphin, the whale, and the other cetacea are

hair, have lungs,* &c. He did not mistake a *bat* for a *bird*, nor confound *mollusca* with *crustacea*, *testacea*, &c.†

To derive from the classification of Aristotle the better reduction of the animal kingdom into four great types, Cuvier has had only to combine the *mammifera*, *birds*, *reptiles*, and *fishes* into one group; that of the *vertebrata*, the *testacea* and the *mollusca*, in another, that of the *mollusca*, the *crustacea* and the *insects* in a third, that of the *articulata*, and to add a fourth group, that of the *zoophytes;* and even the indication of this is found in Aristotle. "The sea-nettles," says Aristotle,

really viviparous." *Hist. des animaux.* "Every animal which gives milk has it in the mammæ, and the mammæ belong to every viviparous animal, to those, for instance, which have hair, like man, the horse, the cetacea." *Ibid.*

* All terrestial animals have lungs, and many aquatic animals also, as the whale, and dolphin, &c." (*Traité des parties.*)

† Here are the principle genera under which different species of animals are comprised: the soft species, as the calmar, the cuttle-fish, &c., are united under the name of *molluscs*; those which are covered with a hard envelope, which are called shell-fish, or *testacea;* as to those whose shell is less hard, such as in the lobster, crab, &c., that is, the *crustacea*, &c., &c."—*Hist. des anim.*

" are not of the genus testacea, and are rather out of the genera we have defined. They are beings, whose nature is equivocal between animal and plant."*

We see how the classifications of Cuvier and Aristotle resemble each other: would they resemble each other thus, if the species had changed, if the animal kingdom studied in our days by Cuvier, was not absolutely the same as the animal kingdom studied two thousand years ago by Aristotle?

2.—On *violent* or *sudden causes*. I mean by *violent causes*, the same causes which have effected the revolutions of the globe. Have the revolutions effected any change upon the *fixity* of the species? They have produced none.

A number, a great number, an almost infinite number of species have disappeared, none have degenerated.

The following objection was made against Cuvier; that the present species might probably be only a degeneration of lost species, a degeneration which has operated little by little,

* *Hist. des anim.* We could not better indicate the nature, *zoo-phyte*.

and by *gradual modifications*. "But," replied Cuvier, "if species have changed by degrees, we ought to find traces of these gradual modifications: between the *palæotherium* and the species now existing, we ought to discover some intermediate forms, but up to the present time this has not happened. Why have not the bowels of the earth preserved the monuments of so curious a genealogy, if it is not because the species of former times were as permanent as our own?"*

Relatively to the point of view that now engages me, I divide the lost species into two classes; either they are very clearly distinct from ours, and in that case they have not degenerated, they have not become ours; or they are so nearly related that we cannot distinguish them, that they are not distinct, that they are the same. These species, remaining the same, have very much less degenerated.

The fossil horse differs in no respect from the living horse. They are the same horses. The type of the horse then, has not been altered by the revolutions of the globe.

Nor has the type of the elephant. Ac-

* *Discours sur les révol. de la surf. du globe.*

cording to M. de Blainville, the *mammoth*, or *fossil elephant*, is the same animal as the present elephant of India. Cuvier states, that they are two distinct species. I hold to the opinion of M. de Blainville: if the *mammoth* is the same animal as the *elephant* of India, then the revolutions of the globe have done nothing to the species. The species has not changed. I pass to the opinion of Cuvier: if the mammoth and the elephant of India are two distinct species, then the revolutions of the globe have not prevented these two species, from remaining distinct. They have not made two species so kindred, to pass from one to the other.

Siberia was once peopled with elephants; these elephants have disappeared, but they have not left modified or *degenerate* elephants in their place.

America was once peopled with *mastodons*. These mastodons have disappeared, but they have not left in their place other kinds of mastodons.

There was once a time when the soil of Paris was covered with *palæotheriums* and *anoplotheriums*, they have disappeared; but

we see no animal now-a-days which we can venture to say comes from these animals by any modification or degeneration, whatever.

Let us conclude then, that the species remain constant, that they are fixed, that nothing has changed them, and that the *violent*, the *sudden* causes, cannot do more, and do no more, than the *slow causes*.

3.—*Of the crossing of species.* If there was in the world a plausible cause for the change of species, it would doubtless be found in the mixture of the species themselves.

When two kindred species mix together, there results from this union a *bi-partate* animal, partaking of the qualities of both, a *mongrel* or *mule*. Here is then a commencement of a new species: true, but this *artificial* species is not durable.

The horse and the ass, the ass, zebra and hemione, the wolf and the dog, the dog and the jackal, the goat and the ram, the deer and the axis, &c., unite and breed; but the individuals born of these crossed unions, these mixed individuals, have only *limited fecundity*.

Examples are quoted of mules which bred

with the horse and ass; but none of mules which have bred with a *mule.*

The mongrels of the dog and the wolf are sterile from the third generation. The mongrels of the jackal and the dog are so from the fourth.

Moreover, if we unite these mongrels, to one of the two primitive species, they soon revert, completely and totally, to that species. My experiments, on the crossing of species, have given me an opportunity of making many observations of this kind.

The union of the *dog* with the *jackal*, gives a mule, a mixed animal, a nearly equal mixture of one and the other; but in which the *jackal* type rather predominates over the *dog* type. I have remarked, in my experiments, that all the types are not equally dominant and stable. The dog type is more stable than that of the wolf; that of the jackal more than the dog; that of the horse less than that of the ass, &c. The mongrel of the dog and wolf, contains more of the dog than the wolf; the mongrel of the jackal and dog, contains more of the jackal than of the dog; the mule of the horse and ass, contains *less* of the horse than of the ass: he has the ears, back, crupper, voice of the ass.

the horse neighs, the ass brays, and the mule brays like the ass, &c.

The mongrel of the dog and jackal contains, then, more of the jackal than of the dog; it has the straight ears, the pendent tail; it does not bark; it is wild. It is more jackal than dog.

This is the first product of the crossed union of the dog with the jackal. I continue to unite the successive produce, from generation to generation, with one of the two primitive roots; with that of the dog, for example.

The mongrel of the second generation does not bark yet, but it has the ears pendent at the tips; it is less wild.

The mongrel of the third generation barks; it has pendent ears, raised tail; it is no longer wild.

The mongrel of the fourth generation is entirely dog.

Four generations, then, have sufficed to restore one of the two primitive types, the dog type; and four generations suffice also to restore the other type, the jackal type.

Thus, where the mongrels, produced from the union of two distinct species, unite together, either become soon sterile, or they unite with

one of the two primitive stocks, and they soon revert to this stock; in no case do they yield what may be called a new species, that is, an intermediate durable species.

Whether, then, we consider the external causes: the succession of time, years, ages, revolutions of the globe; or internal causes, that is to say, the crossing of the species, the species do not alter, do not change, nor pass from one to the other; the species are *fixed.*

§ II.—OF THE VARIETIES.

"The imprint of each species," says Buffon, is a type, the principal features of which are engraved in characters ineffaceable and permanent for ever; but all the accessory touches vary: no individual perfectly resembles another; no species exists, without a great number of varieties. * The *varieties* are the differences in the *accessory touches* of the species.

In each species there are two very manifest *tendencies.* 1°. the tendency to vary within certain limits; and, 2°. the tendency to transmit

* Vol. III. p. 418.

from generation to generation, the modifications acquired by a first.

1.—*Of the tendency of the species to vary within certain limits.* Nothing is more marked than this tendency. Under the same climate, in the same place, in the same litter, are often, indeed almost always, found slight differences in conformation, height, and colour; the ears are straight or pendent, some are large, some small, the hair long or short, &c. "No individual perfectly resembles another," as Buffon says.

Again, nothing is more manifest than the tendency; but, nothing, also, is more manifest than the limits of this tendency: straight or pendent ears, hair long or short, are only superficial characters—the accessory touches of the being. The profound character, that which makes the reality and unity of the species—the *continuous fecundity*—this character is not affected, is not injured. All these individuals with long and short hair, with straight or bent ears, &c., are fruitful together, and with a *continuous fecundity.*

Species was defined as a collection of individuals, more or less resembling each other, and all come from each other, or, from common

parents. I have shown that resemblance is only a secondary condition; the essential condition is descent: it is not resemblance, but *succession* of individuals that makes the species.*

2.—*Of inheritance*, or, the *tendency of the species to transmit*, from generation to generation, the tendencies acquired by a first. If the *variations*, the *modifications*, acquired by a first generation, were not transmissable from one generation to another, these *variations* would remain individual and peculiar; they would produce neither *variety*, nor character of *variety*. It is only because they transmit, that they make *variety*. And they not only transmit, but they develope—they increase: we can render them excessive; we can also correct and restrain them. We render them excessive, by uniting together individuals which have the same variations—the large with the large; the small with the small, &c. It is in this way we breed all our varieties of large horses; all our varieties of little dogs, &c.

We restrain and correct them, by uniting together the individuals which have opposite

* See the Author's *Histoire des travaux de Cuvier*.

variations and modifications—the small with the large, those with long hair with those with short, &c., in balancing one excess by a contrary excess. In *contrasting*, as Buffon says, in *contrasting* the forms.

I do not now speak of *climate*, of *food*, of *temperature*, of *domesticity*. The influence of all these causes upon the variation of the *species*, that is, upon the production of varieties is too well known for me to dwell upon. I only remark that these are simple, mediate, distant, external causes, and which have effect only because the immediate, near, internal causes lend themselves to this effect, and favour it. The action of *climate*, *food*, *temperature*, would be in vain; if the species had not a certain tendency to vary, it would not vary; and, in like manner, without a certain tendency to transmit the acquired variations, they would end with the individual, and would not produce a variety. All the mechanism of the formation of varieties turns upon these two internal causes. The *tendency* of the species to vary, and the *transmission* of the acquired variations. But these two forces combined, the primitive tendency to uncertain *variation* and *transmission* of acquired varieties, how far do they go? Do they go as far

as to make a *variety* come from a *species*, and so far as to make this *variety* no longer fruitful with the other *varieties* of its *species ?* Certainly not.

All our varieties (and the number is almost infinite) of dogs, horses, sheep, goats, &c., are in every species fruitful together—continually and unlimitedly fruitful.

Species is not *variety ;* it is not this, more than that; one is not preferable to the other, and this we must carefully note: *species* is a whole given by *varieties.*

All the varieties of *dogs*, comprise the species *dog*. All the varieties of horse, that of the horse. All the varieties of goats, that of the goat, &c., and all these varieties have equally, for stock and limits, *species.* All come from the species, and none go out of it. All come from it by generation, and all remain attached to it by generation—by community of blood, of germ, and of reproduction.

" When," said Buffon, " after ages had flown, and continents were traversed . . . man wished to accustom himself to extreme climates, to people the lands of the south, and the icy regions of the north, the changes have become so great and striking, that it might be con-

cluded that the Negro, Laplander, and White form different species, if we were not assured of the contrary, that this White, this Laplander, and this Negro, so dissimilar, can nevertheless be united together, and propagate in common the great and single family of the human race. Thus their stains are not original; the dissimilarities are only exterior; these alterations of nature are only superficial; and it is certain that all make only the same man: he who is varnished black under the torrid zone, and he who is tanned and dwarfed by the icy cold of the north.*

To sum up: there are superficial characteristics, and these characteristics *vary;* but there is a profound characteristic, which constitutes the unity, identity, and reality of the species; which is, *continuous fecundity*; and this characteristic *never varies:* it is immutable.

Thus, then, always given by *the species*, and going out of *the species*, the varieties never alter it, never change it, and this not being understood, has caused it to be said that species *vary*; but being better understood,

* Vol. IV., p. 110.

enables us to see that, in fact, they vary, but always within certain fixed and impassible limits.

Varieties constitute the extreme limit of the variation of the *species*.

§ III.—OF THE PROPORTION OF THE SEXES IN BIRTHS.

I profit by the occasion afforded me in this chapter to indicate the result of some observations I have lately collected, and which bear very closely on the subject I now discuss.

"In the species *man*," says Buffon, "there is about one-sixth more male infants born than females; and we shall see in the sequel that it is the same with every species of animal upon which observation has been directed."*

"It appears almost certain," says he, elsewhere, "that the number of males which is already

* Vol. I., p. 464. "The table we have arranged, presents a summary view of the population of France, for each of the thirty-two years, comprised from 1817 to 1848. During these thirty-two years, there were born in France, 15,947,668 boys, and 15,020,756 girls. The relation of the first number to the second, is nearly equal to seventeen-sixteenths. The mean annual births of boys exceed those of girls by one-sixteenth." *Ann. de Bur. des longit.* 1850.

larger than that of females in the pure species, is yet larger in the mixed species."*

We must remark these words: *it appears almost certain.* In fact, Buffon, quotes only four facts in support of this second assertion. The union of the *goat* with the *sheep* gave him, in 1751, nine mules, seven males, and two females. A union of the same goat and the sheep gave him, in 1752, eight mules, six males, and two females.

On the other hand, he learned, in 1773, from the Marquis Spontin-Beaufort, that the union of the *dog* with the *wolf* gave four mongrels, three males, and one female. Lastly, upon nineteen young ones, produced from a goldfinch, and a canary, Buffon counted only three females.

"These," added he, "are the only facts that I can offer as certain upon this subject, which appears to have been little studied, but which, notwithstanding, merits the greatest attention; for it is only by combining many similar facts, that we can develope what remains mysterious in generation, by the union of two individuals of different species, and determine the pro-

* Vol. IV. p. 199.

portion of productive powers of the male and female in every production."

I have combined a much greater number of observations than Buffon; yet this larger number is still very small.

Since 1845, the date at which I began to occupy myself with this kind of study, I have collected fifty-nine facts.

Fifty-nine litters, derived either from the union of the *wolf* with the *bitch*, the *dog* with the *jackal*, or the union of the *mongrels* together, gave me two hundred and ninety-four young ones; one hundred and sixty-one of which were males, and one hundred and thirty-three females; that is, one *sixth* more *males* than *females*. The speculation of Buffon is thus confirmed and justified; the number of males, already larger than that of females in the pure species, is much larger still in the mixed species.

In the pure species, it is only a *sixteenth;* while, in the mixed species, it is more than a *sixth*.

In this series of chapters I have shown, that

* Vol. IV., p. 193.

in the animal economy, everything is subject to fixed laws. The duration of the ages of life; the total duration of life; the proportion of species, in the different ages of the world; above all, the nature and the permanence of the species; and even in this matter (so delicate, that it is scarcely susceptible of being submitted to rules), —the predominance of males over females in births.

CHAPTER III.

ON THE FORMATION OF LIFE.

§ I.—ON THE CONTINUITY OF LIFE, AND ON SPONTANEOUS GENERATION.

THE first law of life is the law of continuity. Life comes only from life. Every living being comes from a parent. The succession of individuals, one born from another, is a *species*.

"An individual," says Buffon, very aptly, "is as nothing in the universe; a hundred, a thousand, are still nothing; the species are the only beings in nature. . ."*

In fact, individuals perish, but life does

* Vol. III. p. 414.

not; before perishing they have transmitted it.

Et quasi cursores, vitaï lampada tradunt.

LUCRETIUS.

Here everything depends upon the point of view at which we are placed. If I consider individuals, I see only successive destruction and reproduction; if I consider species, I see only continuity and perpetuity.

"Let us, for a moment," says Buffon, "put the species in the place of the individual. Let us imagine what would be the view of nature to a being who would represent the entire human species . . . . . the ideas of renewal and destruction, or, rather, those images of life and death, however grand, or universal they appear to us, are only individual and particular. Man, as an individual, thus judges nature; the being, which we have put in the place of the species, judges more largely, more generally. In this destruction, in this renewal, in all these successions, he will see only permanence and duration; the season of one year is, to him, the same as that of the preceding year; the same as that in all

ages; the thousandth animal, in the scale of generations, is, to him, the same as the first animal. . . . In the stream of time, which devours, absorbs, and swallows-up every individual of the universe, he finds the species constant—nature invariable; the relation of things being always the same, the succession of time appears *nul*; in his eyes, the laws of renewal just compensate those of permanence. A continual succession of beings, all resembling each other, is equivalent, in fact, only to the perpetual existence of one of these beings."*

From these lofty abstractions, let us pass to facts.

The life of each species is like a chain, through which all the links *come*, if I may so express it, and *go out* from each other. When a link fails, the species is lost.

I will take an example: for which the pigeon species is very suitable.

Every pair of pigeons gives two young ones; a male and female. The first couple give a second, the second a third, the third a fourth, the fourth a fifth, ... the nineteenth a

* Vol. III. p. 415.

twentieth. Suppress the twentieth, (for I do not here take into account the collateral branches,) and the species pigeon is lost.

I have just said that each pair of pigeons gives two young ones: a male and a female. Adding that, of the two eggs laid, it is almost always the first that gives the male.

"Generally," says Aristotle, "the pigeon produces from one pair, a male and female, and generally also, the egg containing the male is the first laid; after a day's intermission, the hen lays the other egg."* I wished to repeat an experiment made by Aristotle.

Eleven successive broods from the same pair of pigeons, gave me two young ones ten times in succession, a male and a female, and the male always came from the egg first laid. At the eleventh time, three eggs were laid; the first produced a female, the second a male, the third nothing.

I return to my subject. Strictly speaking, life does not recommence with each new individual, but only with the species. For each species, life has only commenced once. Starting

* *Hist. des Anim.* Liv. VI. ch. iv.

from that, it passes from one being to another, without interruption, without rupture to all the species which still exist at the present time; all the species where a rupture has been made, or an interruption produced, where the *continuous thread* of life has been broken, are now lost species.

And these lost species are never renewed. At one time the soil of Egypt was covered with *mastodons*, *elephants*, and enormous *reptiles*; at one time the soil of Paris was covered with *palæotheriums*, *lophiodons*, &c., all these animals have disappeared, never to return.

We throw ourselves in vain upon *spontaneous generations*. Spontaneous generation is only an old hypothesis, and of all hypotheses the most gratuitous.

"It is probable," says Plutarch, "that the first generation has been made entire and complete of earth,"* . . . . that is to say, by spontaneous generation; he admitted, however, that

* *Les Propos de Table*, Liv. II. "Without needing," adds he, and the addition is curious, "such tools and vessels as nature has since invented and made in females, who engender, and bear on account of their weakness and imbecility."

in his time, only *mice* were formed in this manner.

Aristotle limited spontaneous generation to *insects*, to *molluscs*, and *fishes*, that is, to animals of which he knew not the true mode of generation.

A physiologist of the present day, M. Burdach, admits spontaneous generation for *fishes*, but he adds, that it would be *too bold* to admit this for *toads* and *frogs*.* We do not understand this scruple. It was already very bold, much more so than M. Burdach supposed, to admit spontaneous generation in *fishes*.

Usually we are not so bold. We fall back upon small animals, because we have not dissected them. "Which is most wonderful in the eyes of a philosopher," said Swammerdam, very sensibly, "an elephant, a whale, or the smallest animalcule? One lives as well as the other, and it is this *living* that astonishes and confounds the philosopher;

* As we believe it possible that fishes are formed in the water, under the influence of air, heat and light, it appears to us, on the contrary, too bold to think that the frogs which have been found alive in the interior of great blocks of stone, have been produced there by putrified organic substances." *Traité de Physiologie*. Vol. I. p. 45. Trad. Franç.

each is provided with all the solid and liquid parts necessary to its existence, to its growth and reproduction; each has its instincts, its inclinations, its habits; all of which appear much easier in the elephant than in the ant, the smallness of which is an additional wonder."*

M. de Lamarck finds that the *polypus* is too complicated to be produced by spontaneous generation; but he says, the *monad* can be produced in that manner. Ehrenberg, who has dissected animals still smaller than the *monad*, and who has discovered in them a structure, in its kind, so marvellous, carefully avoids saying this.†

In proportion as science makes a step in advance, the partizans of spontaneous generation fall in the rear. They fly from fishes to insects, and they cling to these last until Swammerdam and Redi come; then they jump from *insects* to *infusoria* and hold on to these until the skill of an Ehrenberg has completely unveiled to us the positive and peculiar generation of these

* *Hist. des insectes.*

† See the valuable work of Ehrenberg on *Infusoria, &c.*

animals, as Swammerdam and Redi have done for the generation of insects.

§ II.—ON THE EQUAL SHARE OF THE MALE AND FEMALE IN THE FORMATION OF THE HUMAN BEING, AND ON THE PRE-EXISTENCE OF GERMS.

The very convenient, but very absurd hypothesis of *spontaneous generation* being put aside, the impenetrable problem of the *formation of beings* presents itself. How is each new being, each new individual produced and formed. To get out of this difficulty, which is not trifling, some very superior minds, philosophers such as Malebranche and Leibnitz, naturalists such as Swammerdam, Redi, and Malpighi, have adopted the idea that the new being does not form itself, that it was always formed; and hence the famous system of the *pre-existence of germs*.

"We ask," says Buffon, "how a being produces its like; and they reply, it was already produced. Can we accept this solution?"*

Bonnet, that decided partizan of the pre-existence of germs, tells us naïvely:

"Philosophy, having recognised the impos-

* Vol. I., p. 440.

sibility of explaining mechanically the formation of organized beings, has happily imagined that they already exist *in little* under the form of germs or of organic corpuscules."*

I beg the reader to remark these words:—*philosophy has happily imagined.* The *pre-existence of germs* is, in fact, only a philosophical expedient, *happily imagined;* and, like all expedients of this kind, *imagined* to mask a weakness.

The celebrated naturalist, Swammerdam, after finding the *butterfly* in the *chrysalis*, the *chrysalis* in the *caterpillar*, the *caterpillar* in the *egg*, excited with enthusiasm at the view of these fine discoveries, exclaimed, " To exhibit my opinion in two words, it is sufficient to observe, that I think there is no true generation in nature; still less, fortuitous generation; but that the production of beings is nothing else than the development of their already existing germs."†

Malebranche and Leibnitz immediately adopted this view.

" Some very exact experimenters of our

* *Consid. sur les corps organisés.* Chap. I., Sec. 4.

† *Hist. des insectes.*

time," says Leibnitz, "have already perceived that it is doubtful if ever an entirely new animal is produced; that animals in life are already *in little* in the semen before conception, as well as in plants."* . . . . "It is here," he also says, "that the transformations of Swammerdam, Malpighi, and Leuwenhöck, who are among the best observers of our time, have come to my aid, and enabled me more readily to admit that the animal does not begin when we suppose, and that its apparent generation is only a development, and a species of augmentation."†

Here we have the *pre-existent germs* established. We know that Leibnitz did not stop there. After having established the principle that beings do not begin, he has very quickly derived the conclusion that they do not end.

"This doctrine being established," says he, "it will be reasonable to conclude, that what does not begin to live, does not cease to live, either; and that death, like generation, is only

* *Œuvres compl.*, Vol. VI. p. 431.

† Ibid. p. 125.

the transformation of the same animal, which is either augmented or diminished."*

Leibnitz wanted ideas which would sustain, follow each other, and form a chain: "I like," said he, "maxims which hold out," and this reminds us of the words of Fontenelle upon his philosophy: "That with him we had seen the end of things, or rather that they have no end."†

Malebranche was no less struck than Leibnitz with the experiments of Swammerdam. "I have heard," he says, "that a learned Dutchman had found the secret of showing in the eggs of the silkworm, the butterflies which come out of them."‡ The theory of *the transformation* of insects had enchanted him, and he was delighted to exhibit it. "Let us turn to some details which refresh the mind. I have now in a box of sand, an insect that

* Leibnitz adds: "And that also discovered to us wonders of the divine skill, which we should never have thought of; that the machines of nature, being machines in their smallest parts, are indestructible, on account of the envelopment of one little machine in one greater to infinity." *Œuvres Complètes*. Vol. VI. p. 431.

† *Eloge de Leibnitz.*

‡ *Entretiens sur la métaphysique.* xe. entretien.

amuses me, and of which I know a little of the history: it is called the *formica-leo* or *ant-lion.* It transforms itself into one of those species of flies, which have a very long belly, and which they call, I think, *demoiselles.**—*Theodore*: I know what it is, Theotime. But you deceive yourself in believing that it transformed itself into a *demoiselle* (dragon fly). *Theotime:* I have seen it Theodore, the fact is certain. *Theodore*: And I, Theotime, I saw the other day a mole which transformed itself into a blackbird. How can one animal transform itself into another? *Theotime:* I understand you Theodore, the *formica-leo* is not transformed, it only casts off its coats and its arms."†

The pretended *transformation*, the *metamorphosis*, then, is only a casting-off. The *butterfly* casts off the *chrysalis;* the *chrysalis* casts off the *caterpillar*; the *caterpillar* casts off the *egg;* the *egg* the *germ*, the real *germ*, in which it was contained, and so from *germ* to *germ* to the first. "God,"

* It is true, we call *demoiselle* the insect of the *formica leo;* but more commonly we reserve this name for the insect of the *libellules*, or dragon-flies.

† *Entretiens sur la métaphysique.* XIe. entretien.

said Malebranche, "has made in a single fly all those which are intended to come from it."*

I wish to omit nothing that can be reckoned favourable to the system of the *pre-existence of germs*. I add then that it has been adopted by Haller,† and by Cuvier,‡ by the greatest physiologist of the eighteenth century, and by the greatest naturalist of the nineteenth. In spite of these imposing authorities, I cannot admit it.

It always happens that the time arrives when a system, whatever it may be, can no longer be maintained, and that time is when the facts

* *Entretiens sur la métaphysique.* XIe. entretien.

† Haller commenced by adopting the system of *epigenesis*, of the *formation of the fœtus* part by part. His interesting studies upon the development of the chicken in the egg, led him gradually to the contrary opinion. I have sufficiently shown in my work, that I incline to epigenesis; but these matters are so difficult, and my experiments on the egg so numerous, that I now propose with less reluctance the contrary opinion, which begins to appear to me the most probable. (11*th Mémoire sur la form. du poulet.* Section XIII., *Corollaires mêlés.*)

‡ "The profoundest meditations, like the most delicate observations, tend only to the mystery of the pre-existence of germs." (*Cuvier. Règne anim.* Vol. I. p. 17. 2nd Edition.)

appear. We can follow a system," said Aristotle, "so long as the facts are unknown; but from the time they are known, we must leave the system."*

Now, in my experiments on the *crossing of species*. I have always noticed that the male had an equal share with the female in the production of the new being.

The *mongrel* produced from the union of the *bitch* with the *jackal*, is a true *mule*: an animal *half dog, half jackal;* an animal formed of two halves, one-half *dog*, and one-half *jackal*.

How reconcile this result with the pre-existence of the *germ!* If the germ pre-existed in the *bitch*, it is all *dog;* it is not half *jackal* and half *dog;* the *jackal* half did not certainly pre-exist in the *bitch*.

I continue my experiment: I take the mongrel, which I suppose to be a female, and I unite it with a *jackal;* I obtain a second mongrel, which is only one-third *dog*. I still continue, always proceeding in the same manner; at the third generation, the mongrel is only

† *De generatione*. Lib. III. cap X.

one-fourth *dog ;* at the fourth, there is no longer any *dog*.

Then, I have changed a germ of the *dog* into a germ of the *jackal ;* for the primitive germ—the germ that was in the *bitch*—was a germ of the *dog*.

By substituting, in my experiment, the *jackal* for the *bitch*, and the *dog* for the *jackal*, I should have been able to change, in the same manner (it is almost needless to say it), a germ of the *jackal* into a germ of the *dog*.

It depends upon myself, then, to change one germ into another ; a germ of the *jackal* into the germ of the *dog*, or a germ of the *dog* into a germ of the *jackal ;* or, rather, to speak more carefully, I change nothing, for nothing was yet formed, nothing was pre-formed, and there are no *pre-existent germs*.

§ III.—OF THE FORCE OF ORGANIC REPRODUCTION AND OF REPARATORY GERMS.

In the animal economy there is not only a force of *development*, which leads, little by little, each part to the prescribed limit marked out for it, but a real and individual force of *reproduction*.

The experiments of Trembley have put this force to proof in the *polypus*. A *polypus* can be cut into pieces; each portion reproduces a new *polypus*.

The experiments of Bonnet, upon the *naïads*, present to us, in a certain sense, something still more astonishing; for the *naïad* is an animal of a much more complex structure than the *polypus*; it is an *annelid*, a *worm with red blood*. The tissue of the *polypus* is entirely homogeneous; the *naïads*, on the contrary, have very distinct organs; a nervous system as marked as that of insects, a double system of blood-vessels, of digestive organs, &c., &c.

We can cut a *naïad* into pieces, and each piece will produce a new *naïad*. Bonnet actually cut one into twenty-six pieces, and they reproduced twenty-six *naïads*. He cut off the head of the same *naïad* as many as twelve times, and it reproduced its head twelve times.* I have frequently repeated these curious experiments with great care.

I have cut some *naïads* into ten, twelve, fifteen, and twenty pieces. Each portion, after

* *Observ. sur quelques vers d'eau douce, &c.*

a few contortions, becomes immoveable. In a short time its epiderm detaches itself, and envelops it in a sort of cocoon. On the second or third days, the two ends of the fragment of the *naïad* appear longer, conical, and semi-transparent; this is the beginning of the reproduction of the head and tail. At the end of three days, the cut portion disengages itself from its envelope, and a complete *naïad* presents itself to our eyes. At each extremity three or four rings of new formation may be perceived, which can be readily distinguished from the old, being much paler. At the end of a month, the caudal end of the new formation has as many as forty rings, and the upper end eight or ten. To the wonder of reproduction, another is added, that of the rapidity of reproduction.

If we cut off the foot of a *salamander* it grows again; if we cut it off a second time, and a third time, it still grows again. Bonnet has cut off the foot of a *salamander*, even four or five times, and the foot was as many times reproduced.

I have cut off the feet of several salamanders, sometimes in the continuity, and sometimes in

the contiguity; that is, sometimes by cutting off a part of the arm or fore-arm, and sometimes in de-articulating the fore-arm from the arm, or the arm from the shoulder. In both cases, the reproduction was perfect.

I have anatomized the new feet, and found the same bones as in the original feet: in the fore feet a *humerus*, a *radius*, and a *cubitus*, a *carpus*, a *metacarpus*, and *four fingers*; in the hind feet, a *femur*, a *tibia*, and a *fibula*, a *tarsus*, a *metatarsus*, and *five toes*. I found in them the same *muscle*, the same *veins*, the same *nerves*, &c.

The tail, like the feet, is reproduced after being cut off, and the reproduced tail has its *vertebræ*, and the same *vertebræ* as the first tail.

The reproduction of the feet is nearly completed at the end of two months and a half; that of the tail is a little slower.

Here then are parts of animals which are entirely reproduced; tails and feet of *salamanders*, heads and tails of *naïads*, &c. How can these facts be explained? Nothing appeared at that time to be easier.

We had imagined *germs of the whole* to explain the formation of the entire being; we

imagined *partial germs*, *local germs*, to explain the *reproduction* of parts.

"All that we can fairly advance," says Réaumur, in his remarkable Memoir of the *reproduction of the claws of the lobster*,* "is to suppose that these little claws, that we see produced, were each contained in little eggs, and that having cut off a portion of the claw, the same juices that served to nourish and make this part grow, are employed to develope and produce the species of little germ of the leg contained in this egg." But Réaumur soon adds, very judiciously, "however convenient this supposition may be, after all, few men will be persuaded to admit it. . . ."

Bonnet has more confidence: he establishes *reparatory germs*, and not only complete germs, but parts, and parts of parts of germs; in a word, of germs "which exactly contain only that which is to be replaced."† These are the words of Bonnet.

And it was necessary for Bonnet to go to that extreme; for, if I cut the whole arm off

* *Mém. de l'Académie des Sciences.* 1712.

† *Œuvres compl.* Vol. VII. p. 267.

the whole arm is reproduced; and if I cut off only the half, the third, or the fourth of the arm, then only the half, the third, or the fourth is reproduced. It was necessary then, in order to render the hypothesis useful, and generally applicable, to suppose also, halves, thirds, and fourths of a germ; but what are halves and fourths of germs? There are neither *reparatory germs* nor *pre-existent germs.*

Frédéric Cuvier, an excellent observer, had well studied the development of the horn of the *stag*, that singular production, which, every year, falls and is renewed with constant regularity.

"At a certain age," says he, "the horn of the stag begins to develope itself; at first, we perceive a slight prominence covered with skin, from which a great number of veins spread out, and in which a vivid heat may be felt. This prominence soon extends itself, and, in some species, divides into several branches; at a certain period, this development ceases, the skin covering the horn loses its heat, dries, and ends by dividing itself into a ragged coat; lastly, this horn detaches itself from its base, and falls; a slight hæmorrhage generally fol

lows. After twenty-four hours, the veins filled with blood are closed, a thin film covers the wound, and we immediately perceive the production of another horn commenced, the extremities of the veins swell, a cap is formed, &c. Thus far, the development of the horn has been uniform, the veins have extended in a certain direction, which is always the same for each species; but, arrived at a certain point, these veins divide; some continue in the same direction as before, while the others take a different direction, always invariable, when no accident interferes; these latter, which have formed a branch, or an antler, soon stop, but the former always continue to develope themselves, and, from time to time, some of them separate to produce other antlers. When this growth ceases, the skin covering it dries anew, and the horn falls, to be replaced by another."

"Animals," adds F. Cuvier, "present few phenomena more inexplicable than this sort of vegetation, or spontaneous production, the *germ* of which we cannot perceive, but which is, nevertheless, subject to such precise and fixed laws."

By my experiments on the *formation of bones*,* I have shown, that while a bone is being developed, it changes, is renewed, is made, unmade, and re-made unceasingly.

When a bone grows in breadth or length, it does not *swell*, to become larger, it does not *stretch*, to become longer. The bone continually changes its body and its heads; it continually changes its *material* while it grows. It is still better to say, once for all, that it is not the same bone that grows; it is a continuation of the bones that disappears, and a new continuation that is formed.

It is not the *same bone* that becomes larger, it is not the *same bone* that becomes longer; but to one of given thickness, succeeds larger and larger bones, to one of given length, a longer and longer.

Where are the germs of these successive bones, of these bones constantly absorbed by the *periosteum internum* in proportion as they are constantly reproduced by the *periosteum externum*?† And the succession, the continual

* See the Author's "*Théorie expérimentale de la formation des os.*" 1847.

† *Ibid.*

substitution of all these bones one with another; while a bone is developed, would it not suffice, of itself, for a proof, and prove in the most striking manner, that there are no germs?

I have examined, in this chapter, three great questions; and, for each of these questions, I have placed a fact beside an hypothesis.

Beside the hypothesis of *spontaneous generations*, I have placed the fact of the *continuity* of life.

Life does not produce itself, it does not recommence with each new individual, or each new being. Life commences only with the species. Reckoning from the first created being of each species, life is not again produced, but continued.

Beside the hypothesis of the *pre-existence of germs*, I have placed the fact of the equal share of the *male* and *female* in the production of the new being.

There are no *pre-existent germs*, for the new being is formed of equal parts of the male and female. If, with Hartsoeker and Leibnitz,* we

* Hartsoeker and Leibnitz take for *primitive germs* the *animalculæ* of the prolific liquors. "I believe that the souls which will one day be human souls, have been like

suppose the pretended germs in the male, the female part does not pre-exist in the male; and if, with Bonnet and Haller,* we suppose the pretended germs in the female, the male part does not pre-exist in the female.

Beside the hypothesis of *reparatory germs*, I have placed the fact of a real and formal force of *reproduction*.

Of the pretended *reparatory germs*, which cannot be seen, cannot be localized, that are *happily imagined*, as Bonnet says, because we

those of the other species, in our ancestors, and in the semen from Adam, and, consequently, have existed from the beginning, always in the manner of organized bodies, which opinion, it seems that Hartsoeker, and many other very clever persons share." (*Théod.* § 91.) "It is true that the souls of the human spermatic animals are not rational, and become so, only when conception determines these animals to human nature." (*Œuvres compl.* Vol. VI. p. 715.) What complacently accumulated hypothesis! What concessions of the mind they require! And to speak plainly, although Leibnitz has had to do with the matter, what senseless suppositions!

* Haller and Bonnet place the *primitive germs* in the *eggs*. Haller even derived his principal argument, in favour of the *pre-existence of germs*, from the union of the fœtus with the egg, which egg, in fact, pre-existed in the female, before any fecundation. (*Elem. physiol.*, Vol. VIII. p. 93.) See Note I. p. 172.

feel the impossibility of explaining the matter of germs, with which we do just as we like, make halves, quarters, thirds of germs, of such germs there is nothing but the word. There are no such germs; but there is a force, evident, and patent—a constant force of *reproduction*.

Perhaps it may be said, that the new forces I propose, the force of the *continuity of life*, the combined forces of the *male* and *female* in the production of the new being, the *reproductive* force in the parts, do not better explain the formation of *beings* or *parts* than the *germs* which I reject.

First, I reply that I do not intend wholly to explain this formation. "It is good clearly to understand," said Malebranche, and with a very deep meaning, "that there are some things utterly incomprehensible."*

Next, I reply that the new forces, facts supply me with and which I accept, are not more obscure than the other forces of life, as *irritability*, *sensibility*, *instinct*, &c.

In speaking of *sensibility*, Cuvier says, "that it is more surprising and more mysterious than *irritability*," but he adds, "if that be possible."

* *Entret. sur la métaphysique.* XIe. entretien.

In my experiments on the nervous system, I arrived at the proper localization of forces. I have localized *positive power* in certain fibres of the nerves, and in the spinal marrow; *sensibility* in certain others, the *co-ordination* of the movements of locomotion in the cerebellum, *intelligence* in the cerebral lobes or hemispheres, even the force of life, the pure and simple force of life, in what I have called the *vital knot*.* All these forces are equally obscure.

Ever since there have been physiologists who have written, there have been physiologists who have sought to define life. Who, among them, has ever succeeded?

"I call vital principle," says Barthez, "the cause which produces all the phenomena of life in the human body."† "This is only a metaphysical definition," says Chaussier; and he, who was certainly not a metaphysician, tells us that "life is the effect of *vital force*." I quote the definition of an old physiologist: "Life is the opposite of death." We smile at this. I quote the definition of Bichat: "Life

* See the Author's *Recherches expérimentales sur les propriétés et les fonctions du système nerveux.*

† *Nouv. élém. de la science de l'homme.* Vol. I. Ch. i.

is the union of the functions that resist death."* We do not laugh at this. Bichat only repeats, in less emphatic terms, the quaint definition of the old physiologist.

Descartes explained life by *animal spirits*, those *spirits* which were *bodies*. "What I here call spirits," says Descartes, "are only bodies."

> J'entends les esprits corps et pétris de matière.
>
> LA FONTAINE.

We must say of life, and of all the forces of life, what this same La Fontaine, this profound philosopher and graceful poet has said of *impression*.

> L'impression se fait : le moyen, je l'ignore ;
> On ne l'apprend qu'au sein de la Divinité,
> Et, s'il faut en parler avec sincérité,
> Descartes l'ignorait encore.

* *Rech. physiol. sur la vie et la mort.* Art. I. p. 1.

PART III.

ON THE APPEARANCE OF LIFE ON THE GLOBE.

CHAPTER I.

LIFE has not always existed on the globe. After having enumerated the various phases of the *successive appearance* of living beings, as he understood it, Cuvier adds, "What astonishes much more, is, that life has not always existed upon the globe, and that it is easy for the observer to recognize the point where it has commenced to deposit its products."*

* *Discours sur les révolutions de la surface du globe.*

Let us take a rapid survey of the three marked progresses which have led us: first, to the attentive examination of *marine shells*, spread everywhere over the dry land, a certain proof, imprinted everywhere, of the ancient flowing of the seas upon the land; from this first point, to the determination of the *strata of the globe*, evidently an effect of the action of water; and for the determination of the *superficial strata* of the globe to that of deep *rocks*, of an entirely different structure, which reveals to us another agent, and conducts our astonished imagination from the spectacle, already so grand, of the *agency of water*, to that more imposing still, the *agency of fire!*

§ I.—ON FOSSIL SHELLS, AND ON BERNARD PALISSY.

"A potter, who understood neither Latin nor Greek, was the first," said Fontenelle, "who, towards the end of the sixteenth century, dared to say at Paris, and in the face of all the learned doctors, that fossil shells were real shells deposited formerly by the sea in the places where they were then found, that animals,

and especially fishes, had given to the figured stones all their different figures; and he defied all the school of Aristotle to attack his proofs."*

This potter, who defied the school of Aristotle, was Bernard Palissy, "as great a philosopher as nature alone can produce,"† as was said by a writer of his own time, "a man of marvellously quick and acute mind."‡

"This man," says Venel, "who was only a simple unlettered workman, displayed an observing genius in his different works, accompanied by so much sagacity, and profound imagination in his observations, such uncommon language, such a fertile imagination, such a correct sense, and views so luminous, that the men most accomplished by study may envy him the degree of light at which he has arrived without aid, and that turn of mind which has reflected it with so much success. The form of his works, even, proclaims an original genius. They consist of dialogues between *Theory* and *Practice*;

* *Histoire de l'Académie des Sciences*, année 1720, p. 5.

† Expressions of Fontenelle. *Histoire de l'Académie des Sciences*, année 1720, p. 6.

‡ La Croix du Maine; *Bibliothèque*, &c., 1584.

and it is always *practice* who instructs *theory*, a very ignorant scholar, and very unruly, but with abundance of good sense. I believe him to be the first who gave public lessons on natural history."*

All this is as true as it is well said. We could not better understand Palissy; this *simple workman* touched upon the highest questions of science, and sometimes solved them. He has solved that of *fossil shells*.

"And because there are found," says he, "stones filled with shells, even at the summits of the highest mountains, you must not think that these shells are formed, as every one says, by nature pleasing to do something new."† He adds:

"When I have closely examined the forms of stones, I find that none of them could have taken the form of shells, or of any other animal, if the animal itself had not constructed its form.‡ We must then conclude,"

* In 1575, at Paris. Venel: Article *Chimie* in the Encyclopédie.

† *Œuvres de Bernard Palissy*, p. 88. Edition of Faujas de Saint-Fond.

‡ *Ibid*, p. 98.

he adds, "that before these said shells were petrified, the fishes that formed them were living in the water; and that both the water and the fish were petrified at the same time, and of this there can be no doubt."*

And of this there can be no doubt. We see what the confidence of Palissy was. And yet he had all the school against him, who would then have it, that *fossil shells* were only *freaks of nature.* But he paid little heed to the school, and did not read its books.

It was not because he would not have been very glad to read, and for the reason which he very naïvely tells us:—because he could have contradicted them.

"I should be extremely glad," he says, "to understand Latin, and read the books of philosophers, to learn from some, and contradict others."† He congratulates himself on being able to read Cardan, whose book, "*De la Subtilité*,"‡ had just been translated into French,§ and "seeing in it such weighty errors,‖

* *Œuvres de Bernard Pallissy*, p. 90.

† *Ibid*, p. 75.

‡ *Hieronymi Cardani. De Subtilitate.* 1553.

§ By Richard Leblanc. Paris, 1556.

‖ But the *weighty error* here is on the part of Palissy, not

to have an opportunity of contradicting a man so much esteemed."*

In his "*Dialogues*," *Practice* is himself, and *Theory* is the school. Or, if preferred, *practice* is the experimental method, the observation of nature; and *theory* the scholastic method, the abuse of the authority of the ancients, everywhere invoked, and almost everywhere misunderstood.

"I assure you," he says to his reader, "that in a very few hours, even in the first day, you will learn more of *natural philosophy*, from facts and things contained in this book, than you would be able to learn in fifty years, in

of Cardan. *Theory*: "And how would you contradict so learned a person, you who are nobody? For, that he has said, that the petrified shells scattered through the universe, were come from the sea, at the time of the deluge." (p. 80.) Here Cardan is quite right, and his erudition saves him. He remembered all that the ancients had already remarked, touching the great displacements of the seas, and these lines of Ovid.

> Vidi ego quod fuerat quondam solidissima tellus
> Esse fretum . . . . . .
> Et procul a Pelago conchæ jacuere marinæ.
>
> METAM. LIB. XV.

* *Œuvres de Bernard Palissy*, p. 79.

reading the theoretic opinions of the ancient philosophers."*

Being unable to read the books of the learned, written in Latin, he imagined an assembly of the learned themselves, to see *if he could draw* them into any contradiction.† "Knowing well," said he, "that if I falsified, there would be Greek and Latin scholars who would openly oppose me, and who would not spare me in the least, as much on account of the crown I had taken from each . . . . as because I had put in my placards, that, if the things promised in them were not true, I would return them fourfold. But, thank God, no man ever contradicted me in a single word."‡ He elsewhere says: "I have never had any other book than Heaven and earth, which is known to every one, and it is given to all to read this beautiful book."

And we feel what he says there, in his style, which has in it something so spontaneous, so unexpected, so direct, and so pure. The style

* *Œuv. de B. Palissy, Advertissement, p.* LXXV.

† Expressions de Palissy, p. 75.

‡ Ibid.

is singularly clear; this clearness comes from genius.

In Palissy, genius was supported by a strong mind, and which always retained its strength, in the midst of the rudest adversity. We read of his long and heroic works on *enamel*,* where he describes himself as having neither help, nor consolation, being every night at the mercy of the winds and rain—wet to the skin.† And what to him appeared most cruel, he was suspected of making base coin; "which," said he, "was an evil that made me pine away; and I walked the streets, my head bent in shame."‡

We cannot read this without pain; he finally succeeded, and then we can understand these beautiful words:

"When I had rested a little while, regretting that no one had pitied me, I said to my

* The discovery of the composition of *glaze* for pottery, cost him more than twenty-five years of study and experiment. "Know," he says to his reader, "that five-and-twenty years have passed since an earthern cup was shown me, turned and glazed, so beautifully, that from that hour, I entered into a dispute with my own mind. . . . . and I commenced to search for enamels, as a man who feels his way in the dark." *Œuvres de Palissy*, p. 14.

† *Ibid*, p. 32 ‡ *Ibid*, p. 22.

soul: What is it that saddens thee, since thou hast found what thou sought'st? Work now."* . . . .

His death was worthy of his life. Persecuted as a partizan of the reformed religion, and imprisoned, at the age of ninety, in the Bastille, he died there. Henry III., who had for a long time protected and loved him, having visited him, said: "My good man, if you will not conform yourself in the matter of religion, I shall be constrained to leave you in the hands of my enemies." "Sire," replied the noble old man, "those who constrain you, can do nothing to me, for I know how to die."†

Palissy, therefore, is the first man of his age‡ who had correct ideas on *fossil shells*. We are astonished now-a-days at hearing a man of genius praised for a thing that appears so simple. It seems that the absurd idea of *freaks of nature* could only be the idea of a

* Œuvres de Palissy, p. 22.

† See the *Notice sur Bernard Palissy. Edit. de ses œuvres*, by Faujas de Saint-Fond.

‡ Or, more strictly, one of the first. Leonardo da Vinci, Fracastor, Cardan, &c., had, about the same time, the same ideas. He who developed them with most power, was Palissy.

school, and that it must have been very philosophical, after the manner of those times, not to perceive true shells in fossil shells.

This absurd idea of the sixteenth century still prevailed in the seventeenth, when Stenon, Scilla, and the great Leibnitz disputed it. It prevailed in the eighteenth, when Buffon attacked it in Voltaire, as I have shown elsewhere.* Absurdity has always its representative, but not always a Voltaire.

I shall presently recur to Leibnitz and Stenon, for other facts and new ideas. But I must first mention Scilla, whose little book on *petrified marine bodies*† is very remarkable.

Scilla was not a naturalist, but a painter. He had made use of his eyes; he saw clearly, and, what must not be undervalued, he judged things wisely; having commenced with the study of facts, he judged books by facts, and not facts by books.

Travelling one day in Calabria, he happened

* See the Author's *Hist. des Travaux et des idées de Buffon.* p. 204.

† *La vana speculazione disingannata dal senso: lettera risponsiva circa i corpi marini che petrificati si ritrovano in varii luoghi terrestri.* 1670.

to see, near Reggio, a *mountain of fossil shells.* While admiring, in surprise, this enormous mass of *marine bodies*, and reflecting upon the cause which had brought them there, it occurred to him to inquire of the inhabitants of the place, what they thought of them. These good people replied, quite simply, that they came from the deluge; a reply that struck Scilla, although certainly neither he nor they who made it, doubted the truth of it.

The book in which Scilla disputed anew the ever-persistent error of *freaks of nature*, is dated 1670. In the preceding year, that of Stenon* had appeared; that of Leibnitz appeared some years subsequently.† All helped. The opinion of Palissy upon *fossil shells*, forgotten for a century, reappeared, never again to disappear, and *geology* obtained its first great fact, and we may even say, that which gave value to all the others; for, once the true nature of *fossil shells* admitted, they have next sought to discover how *marine bodies* could be found on the land, the idea of the

* *De solido intra solidum contento, &c.*

† *Protogæa, &c.*, 1683.

revolutions of the globe comes, and *geology* is born.

§ II. ON THE ARRANGEMENT OF THE EARTH IN STRATA, AND ON STENON.

Stenon was born at Copenhagen, in 1638. He began by studying anatomy under Thomas Bartholin, celebrated by his discovery of the lymphatic vessels; he soon became so himself by that of the *excretory duct of the saliva*, which, even now, bears his name. Arrived at Paris in 1664, we notice him often at the meetings held by Thévenot,* which were the cradle of the Academy of Sciences.

It was there he read his beautiful *mémoire* on the brain. Winslow, the greatest anatomist of the eighteenth century, was his nephew. Denmark has the glory of having produced three of the greatest anatomists of modern times, Thomas Bartholin, Stenon, and Winslow.

From Paris, Stenon passed to Florence. Florence was then what Paris was soon to be, the home of the sciences. The Academy *del*

* They were first held at Montmort. See the Author's book, entitled: *Fontenelle, ou de la philosophie moderne relativement aux sciences physiques.*

Cimento, offspring of the mind of Galileo, and which also possessed Borelli, Redi, and Viviani, hastened to adopt him.

In 1672, he returned to Copenhagen, where the King, Christian V., gave him a professorship of anatomy. He subsequently quitted Denmark again for Tuscany.

During his first stay at Florence, he had embraced the Catholic religion; this time he entered the Church; he was first bishop, then vicar apostolic for the north of Europe, and died at Schwerin in 1687.

Stenon was a man of genius. His ideas on the brain were the first of any value we have had on the structure of this organ. Deluc calls him the *first true geologist**. He began the *anatomy of the brain*, and he began *geology*.

With respect to the matter now under consideration, the *arrangement of the earth in strata*, Stenon appears to have perceived everything. He has, at least, clearly seen these three great points: first, that the strata of the earth are only sediments deposited by a fluid; second, that the material of which they are composed

* Abrégé de Géologie. p. 8. Paris, 1816.

has been, formerly, suspended in this fluid; and third, that all these strata were at first horizontal; from whence it follows, that every stratum, now perpendicular or inclined, has been raised by some cause posterior to its formation, or in one word, and as we now say, that every *inclined stratum* is a shifted stratum.

He saw, also, *marine shells* spread everywhere upon the dry land, proving the irruption of the waters upon the earth. "Wherever we find," says he, "*marine deposits* there, the sea has certainly rested, either by its own *overflowing*, or it has been forced by the *materials vomited* by volcanoes."*

The celebrated Woodward, whose chief merit consists, however, in having well understood the arrangement of the earth in strata, has done little but add some details to this first collection of observations and ideas.

"Whoever will consider," says Woodward, "that we find a prodigious quantity of shells and other bodies, whose origin is in the sea, incorporated and contained in all kinds of stones,

* *De solido intra solidum*, &c., p. 28. "Certum est eo loci aliquando mare exstitisse, quocumque modo, sive propria exundatione, sive montium eructatione eò pervenerit."

in marble, chalk, &c.; that these bodies are lodged in terrestrial matter, commencing near the surface of the earth, even to the profoundest depths; that they are found in all known parts of the world, and even upon the summits of the highest mountains—whoever examines, as he ought, will have no need of seeking other proofs to understand that the earth was actually dissolved, and that it was afterwards formed anew."*

Lastly: what Stenon and Woodward have both seen, and both almost alike, is the astonishing relation of these things with the deluge, as related in the most ancient of our books.

"Respecting the first state of the earth," says Stenon, "nature and Scripture agree upon this point, that everything was covered by the waters."†

And Woodward says: "As to Moses . . . . I take the liberty of examining the accuracy of what he relates, and comparing it with the facts; and

* *An essay towards the natural history of the earth*, &c.

† *De solido intra solidum*, &c., p. 69. "De prima terræ facie in eo Scriptura et natura consentiunt, quod aquis omnia tecta fuerint."

seeing that his history is in entire conformity with the truth, I candidly declare it."*

§ III. ON THE ORGANIC BODIES CONTAINED IN SOLID ROCKS, AND ON STENON.

The title of Stenon's book is, *On the solid contained in the solid*, which may be simply expressed, *on the fossil organic bodies contained in solid rocks.*†

The metaphysical style, which is not good, even in metaphysical works, greatly injures that of Stenon. It was the vice of his times. We must disregard the style, and look at the substance, which is admirable.

The fossil shells spread through the ordinary strata of the earth, fully proves that the sea has covered the earth, and that, doubtless, is much; but it does not prove, what is much more, that many *rocks*, now *solid*, have been

* *An essay towards the natural history of the earth*, &c.

† *De solido intra solidum naturaliter contento dissertationis Prodomus*, 1669. It was, in fact, only the *preface* to an unpublished work; but we may regard this *preface* as a *summary*, as the excellent *summary* of all his observations and discoveries upon the revolution of the globe in general, and particularly upon the different *states of the earth* in Tuscany, *(variæ mutationes quæ in Etruria contigerunt.)*

liquid, or held in suspension by a liquid; and the *organic bodies* contained in the *rocks*, prove it.* For *organic bodies*, that is, *solid bodies*, to be found contained in solid rocks, these rocks must have begun by being *liquid*.

Such is the great fact demonstrated by Stenon, and which Palissy had already indicated.

"I have found," says Palissy, "mountains where there are thousands of different petrified shells, so near each other, that we could not break the rock of these mountains in any part, without finding quantities of these shells, which testify that they . . . have been petrified

* "It is now certain that all stones, without exception, have been fluid, or at least, in the state of soft paste, which has dried and hardened. To be assured of this, it suffices to have seen a single stone, in which some foreign body was inclosed, which could not have entered it, if it had always been of the same consistency, for this single stone testifies for every other; but they may be seen without number, and we may see them every day, containing foreign bodies enclosed, and it is no longer worth while to remark them. Besides, there is an infinity of stones called *figured*, which have been very finely and delicately moulded on different shells, which show us that the paste of which they were formed was extremely soft and fine." *Hist. de l'Acad. roy. des ciences*, p. 8. 1716.

at the same time that the earth and the waters they inhabited were also petrified."*

§ IV.—ON THE DISTINCT PRODUCTS OF FIRE, AND WATER, AND ON LEIBNITZ.

Leibnitz, about 1680, was charged to write the history of the Princes of Brunswick. From the history of these princes, he passed to that of Brunswick itself, and from the history of Brunswick to that of the Earth. This was the turn of his genius: seeking in everything the origin and the end, and almost always concluding that things have neither beginning nor end. It was of him, that Fontenelle said, "that he had seen the end of things, or that they had no end."

He published, in 1683, his history of the earth, under the title of *Protogæa.*†

He saw, from the first, that fossil shells are only the remains of real animals; then he perceived that the sea had covered the earth for a long period; and, so far, he agrees with Palissy, Stenon, and Woodward, who all, in fact will

* *OEuvres de Bernard Palissy*, p. 92.

† *Protogæa, sive de prima facie telluris &c.: Act. Lips.* 1683.—Gott. 1748.

have it, that everything began with water. But what they called *beginning* he did not. His views carried him beyond. Before the *aqueous state* of the globe, he saw another much older, this was the *igneous state*. The earth began by being burned; everything in it was submitted to the action of fire; everything is glass, or of the *nature of glass*.*

The comprehensive genius of Leibnitz embraced the whole extent of time. First among men, he established the two principles which have successively formed and re-formed the globe, *fire* and *water*, and henceforth, every effort of *geology* will be to discover the distinct effects of these two great agents.†

§ V.—ON FONTENELLE.

The facts, the history of which to the present date I have just written, had an immediate and contemporary historian, Fontenelle. Is it not curious to see how he has judged them?

* ". . . Hinc facile intelligas vitrum esse velut terræ basin, et naturam ejus sub cæterorum plerumque corporum larvis latere . . ." *Protogæa*, p. 5, *edit.* 1748.

† "Leibnitz was the first who essayed to distinguish the parts of the earth raised by fire, and the others deposited by water." (*Cuvier, Eloge de Saussure*, p. 414.)

The first time he spoke of it was in 1703, on the occasion of a *mémoire* by Maraldi upon the stones figured with imprints of fishes, and upon fossil shells.

"What can have brought," says Fontenelle, "these fishes and shells upon the land, and even to the tops of mountains? It is probable there are subterranean fishes, as well as subterranean waters, and these waters, raised in a state of vapour, perhaps carry with them very light eggs and seed; after which, when they are condensed and return to the water, these eggs are hatched, and become fishes or shells."*

The second time was in 1706, on the occasion of a communication from Leibnitz, and now, as we may naturally suppose, it is no longer the question of the *ascension* of *eggs* and *light seeds*. The mind of Fontenelle progressed. "It appears by many signs," said he, "that great physical changes must have taken place on the surface of the earth. M. Leibnitz thinks that the sea had formerly covered almost everything. Hence come the shells on the mountains."†

* *Histoire de l'Académie*, année 1703, p. 23.

† *Ibid.*, année 1706, p. 9, and fol.

The third time was in 1708, *à propos* of Stenon, when Fontenelle went much farther. He conceived the *primitive fluidity* (that is, the *solution*, the *suspension* in water) of the superficial strata of the globe. "Parts of terrestrial or aquatic animals, branches of trees, leaves, &c., found in beds of stone, very deep even, confirm the system of the fluidity of the earth. By what other means could all these have been enclosed there?"*

Lastly, in 1727, he says: "There have been great convulsions on our terrestial globe, especially great inundations. It is only to be feared that we shall henceforth too much neglect the new proofs we may discover of a truth so well established."†

Fontenelle was wrong in his fears; some years after he wrote those words, Buffon published his *Theory of the Earth.*

I cannot avoid making a remark at this place. The last *éloge* Fontenelle wrote, was upon Dufay; in which he announces Buffon. "The selection of M. de Buffon, as proposed

* *Histoire de l'Académie*, année 1708, p. 30.

† *Ibid.*, année 1727, p. 4.

by Dufay, was so good," says he, "that the King had no desire to make another."

Singular succession of genius and glory! Fontenelle announced Buffon: Buffon came, to be soon followed by Cuvier.

CHAPTER II.

As soon as Leibnitz perceived this great fact, that our globe had begun by being in a state of *incandescence*, in a state of *liquefaction*, caused by fire, another great fact appeared also, that *life* had not always existed on the globe.

The *igneous state* of the globe necessarily excluded *life*.

After thirty years' meditation* upon the ideas of Leibnitz, of which, at first, he had not comprehended all the force,† Buffon

* See the Author's *Histoire des travaux et des idées de Buffon*.

† "The earth, it is generally admitted, must end by fire; according to Leibnitz, it has begun by it. . . . To pretend,

wrote his magnificent book, *the Epochs of Nature*. From this book dates the *chronology of the globe*.

§ I.—ON BUFFON, AND ON THE PERIOD WHEN LIFE WAS ABLE TO EXIST ON THE GLOBE.

Buffon reckons seven great *epochs* of nature.

The first is that *when the earth and planets took their form.*

The second, *when matter, being consolidated, formed the interior rock of the globe.*

The third, when *the waters covered our continents.*

The fourth, when *the waters retired*, and when *life* first appeared upon the globe.

"At the same time that the land was raised above the waters, and covered with all kinds of

with Leibnitz, that the earth has been a sun, is to say what is equally possible or impossible . . ." (Vol I. p. 101.) Buffon speaks thus of Leibnitz in his first work, *La Théorie de la Terre;* in his *Epochs of Nature*, he adopts the ideas of Leibnitz, adding to their force by his eloquence, and no longer treats them as those *of every one*.

large trees and plants, the whole sea was peopled with fishes," &c.*

The fifth *epoch* presents the birth of terrestrial animals.

The ancients supposed the world *eternal and always the same.*

"The world," said one of them, Ocellus Lucanus, "has always been the same, in the same fashion, always equal and like itself."

The science of our days has taught us, (and this is the greatest instruction it could give) that this world,—and confining ourselves in this place to the part under consideration—that the globe is a *work of a hand*, the work of a divine hand; that it has had its origin, its development, its successive progresses; that it began under one form, was continued under another, from which it passed to a third; that a time has arrived, when *life* has at length been able to appear; that it has appeared, and that, since it has appeared, it has often been disturbed by great and terrible events.

"Life," says Cuvier, "has been disturbed by

* *Epoques de la nature* Epoque. IV.

† *Ibid., époque* V.

frightful events. Living beings, without number, have been the victims of these catastrophes: the inhabitants of the dry land, have been swallowed up by deluges; others, which peopled the waters, have been dried up by the bottom of the ocean being suddenly upraised: their varieties have ceased for ever, and have left in the world only some remains, which the naturalist can, with difficulty, recognize."*

From Buffon, dates the *Chronology of the globe:* from Cuvier, dates the science of *lost beings*, or *Palæontology*.

* *Discours sur les révolutions de la surface du globe.*

CHAPTER III.

§ I.—ON DELUC, AND ON THE RECENT DATE OF THE LAST DELUGE.

AMONG all the revolutions which have successively disturbed the surface of the globe, there is one which touches even the history of mankind. For the others, we have only the testimony of the monuments of nature: here, to the monuments of nature are united the traditions of mankind. The last deluge is the great remembrance that men have transmitted.

And, although it appears very ancient, when compared with what we regard as ancient in our ordinary chronicles, yet it is but slihgtly so.

This Deluc clearly saw: he fully understood the recent date of the last deluge (a great fact, vainly called in question), and the surprising connection, presented by the whole surface of the globe, with the narrative in the book of Moses. Deluc's book,* full of interest, notwithstanding its length, its digressions, and unnecessary complications, well deserves the appropriate title of the *Commentary on Genesis.*

From the beginning, Deluc divides the history of the earth into two distinct histories: the one is the history of what preceded the deluge; the other the history of what followed it: the one is the *primordial history*, the *ancient history*; the other is the *modern history*, the *present history.*

Buffon, the first who dared to mark the *epochs* fixed in the history of nature, dared also to mark the *duration* of each. The first continued twenty-five thousand years; the second, ten thousand; the third, fifteen thousand; the fourth, ten thousand. The

* *Lettres physiques et morales sur l'histoire de la terre et de l'homme, &c.*, 1779.

earth was exactly sixty thousand years old, (if we believe Buffon) when nature, in her first moment of repose, yielded her noblest productions, &c., &c.*

Deluc was not so bold. Wiser than Buffon, at least, more reserved, because he lived later, he saw the periods of *ancient history*, more and more remote, without marking the dates, which, hypothesis only would have given: he marked only a single date, given him by facts—the date of the last *deluge*.

"In that portion of the history of the earth which I call the *ancient history* of our globe, I had for my guide, only ancient monuments, greatly disfigured by time; and it is important that they still bear characters sufficiently precise to enable us to decipher the causes and determinate successions, although, in thus discovering periods, we cannot calculate their lengths. Fortunately, we have much more aid in the *modern history* of our planet. I mean that period of its existence in which we now live."†

* *Epoques de la nature.* Epoqué VI.

† *Lettres physiques et morales sur l'histoire de la terre et de l'homme*, &c., Vol. V. XIe. partie, p. 489.

He adds: "Since the revolution which separates the two portions of this history, that is since the existence of our continents, all the *causes* which began to influence it, have continued to act; and while we see them in action, we can measure their effects, past and present: what we must do is, to estimate the time which has elapsed since they began *to operate.*"*

Cuvier said, after Deluc, "In measuring the effects produced in a given time, by causes now acting, and comparing them with those they have produced since they began to act, we can almost determine the instant when their action commenced; which is necessarily the same as that when our continents took their present form, and that of the last assuaging of the waters."†

What, then, are the *causes* which, according to Deluc and Cuvier, *operate*, *act*, upon our continents since the last *deluge;* or, more

* *Lettres physiques et morales*, &c., Vol. V., XIe partie, p. 490.

† *Discours sur les révolutions de la surface du globe.*

strictly, since the falling of the waters with which they were covered ?

These *causes* are, *vegetation, ice, rivers, rain,* &c. &c.

When our continents were dry, *vegetation* began to produce strata of vegetable mould; high mountain-peaks began to be covered with ice; the rivers began to carry their deposits to the sea, &c.. &c. We can then employ these *deposits,* this *ice,* these *strata,* &c., which continue to grow every day, and which growth is regular and *measured,* to measure the time that has elapsed since the last assuaging of the waters—since the last *deluge.*

This is what Deluc does. He takes all these *causes,* one after the other,—*vegetation, ice, rivers,* &c.; he sees them act; by their present progress, he estimates their past progress; he ingeniously and properly names them, *natural chronometers;* and all these *chronometers* give him the same result; namely, the recent, very recent date of the last *deluge.*

The chronometers of Deluc are the happy means by which he establishes his new *chronology;* he observes and compares them; he

studies everything that could have interfered with their progress.

"If," says he, "starting from the quantity of strata of vegetable mould which we find, now-a-days, and from what we know of the manner in which they are formed, we should wish to deduce the age of our continents, without having regard to what must have retarded vegetation in its origin, we should make them younger than their known history will permit."*

Respecting rivers, he says: "At first the rivers carried to the sea a quantity of materials incomparably greater than they now carry; and, consequently, their accumulation, considered by simple comparison of its progress with what already exists, may lead us to an error of time; this will be an error of excess, and not of deficiency. Yet, still, this phenomenon, so *chronometric*, stands upon the same chronologic base."†

Lastly, he concludes that our *continents are not ancient*; that their origin does not go back

* Vol. V., 2nd part, p. 491.

† *Ibid.*, p. 498.

more than *five or six thousand years*,* and that "the first of our sacred books, *Genesis*, contains the true history of the world."†

Such is the great fact demonstrated by Deluc, which would have greatly astonished the age in which he announced it, if, with respect to all facts of this kind, this age had not adopted the same views. Buffon had well observed: "From the completion of the works of God, that is, since the creation of man, only six or eight thousand years have elapsed."‡ But the words of Buffon were put to the account of his compliance with the Sorbonne. Dupuis, the celebrated author of the *Origine de tous les cultes*, affirmed that, "the world had not been made; that it had always existed; that it had never seen birth . . ."§ and Dupuis was admired.

* "I think, with Deluc and Dolomieu, that if there is anything proved in geology, it is, that the surface of our globe has been the victim of a great and sudden revolution, the date of which cannot go far beyond five or six thousand years . . ." *Cuvier: Discours sur les révolutions de la surface du globe.*

† *Vide* Vol I, p. 9 and 24; Vol. V. p. 507, &c., or rather, see the whole work.

‡ *Epochs of nature: Preamble.*

§ See the *Abrégé de l'Origine de tous les cultes*, Chap. I.

On this point, philosophy did not yet believe science. And more than twenty years after Deluc, Cuvier himself—he who ought to have added so much to these new truths, still proposed them with much reserve.

"These ideas," said he, in one of his fine *rapports*, "are also those of many celebrated naturalists; especially if we limit them to the last change. Your colleagues think, personally, even to be able to adopt a part, although they very well understand that the motives that determine them cannot have the same influence upon every one; but they do not believe they ought to engage the Class to decide upon similar subjects."*

These were the views of Cuvier, in 1806. Let us see what they were some years, later, in 1812.

"In examining well," says he, "what has passed upon the earth, since it has become dry for the last time, and since the continents have taken their present form, we clearly perceive

* *Rapport sur l'ouvrage du Père Chrysologue de Gy*, entitled: *Théorie de la surface actuelle de la terre*, 1806.

that this last revolution, and, consequently, the establishment of our present societies, cannot be very ancient. This is a result at once the best proved and the least expected of sound geology; a result much more valuable, as, by an uninterrupted chain, it unites natural with civil history."*

§ II.—CORRELATION OF THE NARRATIVE OF MOSES WITH THE MONUMENTS OF NATURE.

Deluc undertook to follow these affinities in great detail. There is no need of this detail. There has been a deluge, Moses says, and the

* *Discours sur les révolutions de la surface du globe.* See note 2 of page 233 "The *deltas*, by their continual growth, constitute, like the *dunes*," says M. Elie de Beaumont, "a sort of *natural chronometer*. . . . It is evident that the formation of deltas has begun with that of dunes, and the support which calculation favours, founded upon two classes of facts so different, appear to me to give great weight to the conclusion that the present period, which is at the same time, the *era of the deltas*, and the *era of the dunes*, dates from an epoch not very distant from ours.

"We see," he adds, "by the limited size of the band of the dunes, compared with its incessant extension, that the period when the movement commenced, is not very remote; it may have been some thousands of years, but not many. If we

whole earth proclaims and relates it, like Moses. Shall we, with Deluc, with Buffon himself, lose ourselves in dissertations on the word *day?* "What can we understand," says Buffon, "by the six days which the sacred writer tells us so precisely, in counting them one after another, but six spaces of time, six intervals of duration?"*

Yes, doubtless; and there is no need to write a dissertation upon it. Deluc finds that Moses does not clearly indicate the precise time when the rains of the deluge commenced. "As to the rains," says he, "which accompanied this catastrophe, they probably commenced before the time mentioned by Moses."† *Probably*, this is to carry one's doubts very far; and I leave Deluc to draw from it what he can.

compare this result with that of the observations respecting vegetation, we shall see that there are certain plants, of which two successive lives form a total, as long as the whole *era of dunes;* there are even, perhaps, some plants as old as the beginning of the present dunes. It is within this very limited circle, that all the history of man is contained."—(*Leçons de géologie pratique*, Vol. I. p. 219.)

* *Epochs of nature. Preamble.*

† Vol. V., 2nd part, p. 652.

What have little proofs to do here when we have great ones?

And, besides, it is not *Genesis* alone that preserves to us the remembrance of these great things. The record of them is everywhere.

"The tradition of the universal deluge," says Bossuet, "is found throughout the world."*

But, still more: there is, if I may so express it, a human *feeling*, *primitive*, and *always preserved*, which dates from this last and great catastrophe of the globe.

"The frightful spectacle of a world destroyed," says Boulanger, in his book, '*l'Antiquité dévoilée*,' "made upon man such strange and profound impressions, that there resulted necessarily, principles which have influenced his conduct, and that of his posterity also."†

But why quote Boulanger, when I can quote Buffon? For Buffon does not disdain to employ the same ideas, and enlarge them by his style. He describes "the first men, witnesses of

* *Discours sur l'histoire universelle,* époque I.

† *L'Antiquité dévoilée par ses usages.* Vol. I. p. 12.

the convulsive movements of the earth .... having only mountains for asylums against inundations, driven often even from these asylums by the fire of volcanoes, trembling upon an earth that shook under their feet, naked in mind and body."* . . .

And, as he so well remarks, "these men, profoundly affected by the calamities of their first state, and having still under their eyes the ravages of inundations, the fires of volcanoes, gulfs opened by earthquakes, have preserved a lasting and almost eternal remembrance of these disasters of the world."†

§ III.—SYSTEM OF DELUC UPON THE RETIRING OF THE SEAS.

I shall only say a few words upon this system, for what we have to seek are new and correct ideas; and the system of Deluc is neither new nor correct.

Leibnitz had imagined‡ vast caverns, whose roofs, in falling, opened large basins, the

* *Epochs of nature. Epoch* VII.

† *Ibid.*

‡ Nihil propius videtur quam ut credamus, fracto telluris

basins of enclosed seas. Deluc adopted these caverns.

The matter to be explained is this: while our continents were covered by the sea, there were other continents. These ancient continents have become the present seas; the seas of that time have become the continents of the present day. How has this change been brought about? Deluc does not perceive the *true mechanism*, which is the *upheaving* of mountains; he stops at the *apparent mechanism*, which is the *subsidence* of the plains. He contests, in Buffon,* the idea of the *internal fires* of the globe, this great idea, upon which all the geology of our time is based. Curious

fornice, ubi infirmioribus fulcris sustentabatur, ingentem massam nudatis cacuminibus in subjectum anteaque inclusum mare procubuisse. Ita aquas antris expressas supra montes exundasse, donec reperto novo in Tartara aditu, perfractisque repagulis clausturæ interioris adhuc terræ, quidquid nunc siccum cernitur denuo deseruere." *Protogæa*, &c., p. 12. "*Ancient continents* have subsided; the sea, overflowing this depressed space, has left its ancient *bed* dried up, which forms our *continents*." Deluc, Vol. V. p. 467. "When some roof fell in, and the sea overflowed these *caverns*." *Ibid.*, p. 481.

* See Vol. V. p. 517, and fol., his *Examen du système cosmologique de Buffon.*

contrast! It is Buffon, the man who *had not seen the mountains*,* who conceived the true idea of their formation, and Deluc, who had passed his life in surveying, exploring and *working* them, (if I may so express myself) is the man who rejects it.

§ IV.—ON THE TRUE MECHANISM OF THE FORMATION OF MOUNTAINS, AND DISPLACEMENT OF THE SEAS.

Seas have shifted their place: *marine shells*, everywhere spread upon the dry land, prove this displacement; the *displacement* of the seas proves the formation of mountains by upheaval; the *upheaval* of the mountains proves the *central fire*.

The *internal fire*, the concentrated remains of the primitive fire which consumed the whole globe, tends unceasingly to react against the *crust* of the globe, to raise it, and in some points to break it. "If," as Humboldt very truly remarks, "we could have daily intelligence

* Pallas formally reproached him with it. "Buffon appears to have judged mountains in general, only by those of France." —See the Author's *Histoire des travaux et des idées de Buffon*.

of the state of the whole terrestrial surface, we should soon be convinced that this surface is always agitated by shocks in some points, and that it is unceasingly submitted to the reaction of the interior mass."*

It is this *incessant reaction*, this *constant* effort of the *interior mass* against the *surface* of the globe, which causes the *upheaval* of mountains; it is the upheaval of mountains which produces the *displacement* of the seas; it is the displacement of the seas which produces the *dispersion* of marine shells upon the dry land, &c.

The present great progress of science is in having traced back all these phenomena, to a single and first cause, that of central fire: the *dispersion* of marine animals, the *submersion* of terrestrial animals, the *displacement* of the seas, the *upheaval* of mountains; and, still more, the *earthquakes*, *volcanoes*, *ruptures*, and the immense *dislocations* on the surface of the globe, &c.

§ V.—ON THE WORK BY DELUC.

Nothing can be more interesting than the

* *Cosmos.* Vol I., p. 237.

subject of this book: the history of the *new world* man inhabits. Some of those who had already written, or attempted to write this history,—Burnett, Woodward, Whiston, &c.—had mixed with it systems, which gave to it an aspect of fable. Deluc's book reveals its true character. Therefore, this book ought to be found in every library. Yet it is not. Why is this?

Because it is composed of six enormous volumes;* because, proposing to speak of natural history, and of the theory of the earth, the author has spoken of everything—metaphysics, political economy, morals, &c. Long as the work is, its diffuse style makes it appear still longer. Yet, in spite of that, Deluc's book will always be read, and should, we might say, be always re-read. Moreover, facts and ideas abound in it. Deluc was a very sagacious

* I say six, because the fifth is divided into two. Deluc himself well understood that his work was too long; in 1798 he gave an abridgment of it under the title of *Letters upon the Physical history of the earth, addressed to Blumenbach, &c.*, but here the genius of Deluc had no longer its first vigour; his ideas have lost their novelty. The original work is the important work, and that which I have examined.

observer; a thinker of uncommon penetration.* Before him and Saussure, no man had yet so profoundly studied the mountains; he visited them very often; he lived on them, we may literally say he had them always before his eyes.

"The cabinet where I study natural history is not," says he, "one of those where imagination alone inspires†. . . . . While writing, I have the great phenomena before me. I have only to raise my eyes, and from my window, even, I contemplate two great ranges of mountains, the Alps and the Jura, of which, no essential details escape me. . . . . It is themselves then that I consult."‡

But, what I specially notice in Deluc is, his noble idea of science; which is certainly not the science to stop at things, but which rises

* He likes singular and paradoxical propositions. He delights to show us, for example, mountains preserved "by a plant, and the feeblest of plants—*moss*." Vol. II. p. 20. In this respect, perhaps, he goes too far, but at bottom, nothing is more curious, often more real, than the result of these fine researches, to which this turn of mind has led him.

† Vol. II., p. 101.

‡ Vol. I., p. 271.

higher, and, to quote the words of the Roman orator, *almost seizes* that which governs and rules them. . . . . *ipsumque ea moderantem et regentem penè prehenderit.**

* *De legibus*, lib. I. Jean-André Deluc was born at Geneva in 1727; he died in 1817.

CHAPTER IV.

CONCLUSION.

We have taken a rapid survey of a great spectacle.

Life has not always existed upon this globe.

To enable life to establish itself upon the globe, it was necessary that the temperature should have been somewhat cool, its surface consolidated, the air freed from the waters, that all the solid, liquid, and gaseous substances should each have taken its proper place upon it,* and when all these things had been brought to this desired point, the same Hand that had conducted them there, has created *life*, and spread it over the earth.

In order that animals could exist, they must

* For, in the incandescent state, all was *fluid*, and *mixed*.

have had a certain temperature; to be able to nourish themselves, they required a certain combination of animal and vegetable substances; to respire, they must have had a certain air, in which a respirable *element* existed; this *respirable* element must have been constantly present, and always in a given proportion.

Newton demonstrated God. The unique law which presides over all the globes of the Universe, revealed to him God, and the unity of God.

Thus, all these conditions necessary to *life*, failing one of which life was impossible—temperature, water, air, *oxygen*, plants for the nourishment of the herbivorous animal, the herbivorous animal for the food of the carnivorous, &c., all these necessary conditions, so admirably combined and prepared for the precise moment when *life* was to appear, prove God and one God. Apparently, there were not two. If there had been two, they would not have harmonized so well together.

END.

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