ABRIDGMENT OF THE CONTEMPLATION OF NATURE BY MR. BONNET OF GENEVA

by John Wesley

Wesley's adaptation of Bonnet's philosophical work exploring God's presence in creation, examining the universe's order and design as evidence of divine wisdom and power. He discusses astronomical systems, planetary motion, and how all creation reflects God's perfect character.

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INTRODUCTION

I raise myself up to the Eternal Reason; I study his laws, and I adore him. I contemplate the universe with a philosophic eye. I search into the relations which by this immense chain constitute one whole. I stop a while to examine some links of it: struck with those marks of power, wisdom, and goodness, which I discover therein, I faintly attempt their description.

Chapter 01 - Of the First Cause

Chapter 1 - Of the First Cause

1. To be self-existent, endued with almighty power, and to will with infinite wisdom, are the adorable perfections of the First Cause. The universe is undoubtedly derived from this Cause. In vain do we endeavour by other means to account for it. We may every where observe order and ends; the effects of an Eternal Self-Existent Reason.

2. What mind can fathom the depths of this abyss What thought can comprehend that power which calls things that are not as though they were God commands the universe to be: the universe is instantly produced. A single act of his will produced the universe; the same act preserves it. But you ask, why is not man as perfect as an angel You mean to say, no doubt, why is not man an angel You may as well inquire why a stag is not a man But the existence of a stag supposes that of herbs to nourish him. Would you still further have had these herbs to have been so many men Their preservation and increase would have depended on the earth, the water, the air, and the fire would you presume to insist in your inquiry, why the constituent parts of these elements were not so many dwarfs

Confess your error, and acknowledge that every being is endued with a perfection suited to the ends of its creation. It would cease to answer that end, the very moment it ceased to be what it is. By changing its nature, it would change its place, anti that which it occupied in the universal hierarchy ought still to be the residence of a being resembling it, otherwise harmony would be destroyed. In the assemblage of all the orders of relative perfections, consist the absolute perfections of this whole, concerning which God said, that it was good.” This immense system of co-existent and successive beings, is no less one in succession, than in co-ordination : since the first link is connected with the last by the intermediate ones. Present events make way for the most distant ones. The germ which expanded itself in Sarah’s womb, was the preparatory cause of the existence of a great people and the salvation of nations.

3. “ The heavens declare the glory of God, and the firmament showeth his handy work.” That sublime genius, who expressed him self with such loftiness of sentiment, was nevertheless unapprized that the stars which he contemplated, were in reality suns. lie anticipated the times, and first sung that majestic hymn, which future, and more enlightened ages should chant forth to the praise of the Founder of worlds. This assemblage of vast bodies is divided into different systems, the number of which perhaps exceeds the grains of sand, which the sea casts on its shores.

Each system then has its centre, either a star or sun, which shines with its own light, and round which revolve various orders of opaque globes, that reflect with greater or less lustre the light they borrow from it; which renders them visible to us.

These globes, which seem to wander among the heavenly bodies, are those planets, the principal of which have the sun for the common centre of their periodical revolutions ; whilst the others,

which are called secondary, move round one principal planet, which they accompany like satellites, in its annual revolution.

Venus and the earth, have each of them their satellite. One will undoubtedly be some time or other discovered in Mars. Jupiter has Thur. aaturn ave, and a ring or luminous atmosphere which seems to perform the office of a number of small moons: being situate far the sun, he would have received too taint a light from it, if his satellite and ring did not augment it by reflection.

We have discovered twenty-seven planets, which at present compose our solar system; but we are not certain that there are not more. Their number has received a great increase by the invention of telescopes more perfect instruments, and more accurate observers, may probably make farther additions to them. The satellite of Venus, discovered in the last century, gives room to hope for still greater success.

4. The comets also are now found to be planetary bodies, whose long routes our astronomers calculate, foretel their distant returns, anti determine their place, appearances, and tract. Upwards of thirty of these bodies at present acknowledge the empire of our sun, and, the orbits which some trace round, are so extensive, that they do not complete their course till the end of a long series, of years, and even many ages. The stars are innumerable ; and the constellations, which antiquity reckoned to be but few in number, amount to thousands. little diameter of the great orbit which our planet describes round the sun, is more than sixty millions of leagues, yet this vast circumference vanishes into nothing, and becomes a mere point, when made use of to measure the distance of the fixed stars.

How great then must the real bulk of these lunimous spots be, that are perceivable by us at such enormous distance! The sun is supposed about a million of times greater than the earth, and a hundred and ten times greater than all the planets put together.

5. Whilst the planets perform these revolutions round the sun, by which the course of their years is regulated, they effect another among themselves, which determine the alternatives of their clays and nights. But how do these vast bodies remain suspended in space What secret power retains them in their orbits, and enables them to circulate with so much regularity and harmony Gravity, that powerful agent, is the universal principle of this equilibrium and these motions. It penetrates into the inmost parts of all bodies. By virtue of this force, they tend towards each other in a proportion relative to their distance and bulk. So that the planets tend towards the common centre of the system, and they would instantly be precipitated into it, if the Creator, when he formed them, had not endued them with a centrifugal motion, by which they are continually kept at a due distance from the centre. Each planet, in constant subserviency to these two forces, describes a curve in consequence thereof. By this means, the same force which determines the fall of a stone, is the ruling principle of the heavenly motions: wonderful mechanism! whose simplicity and energy give us unceasing tokens of the profound wisdom of its Author. The globe of earth, which is externally divided into lands and seas, nearly level in their surfaces,* is formed within, at least to a certain depth, of beds of heterogeneous matter, that are almost parallel, more or less dense, and of a finer or coarser texture.

* Comparatively so; the highest mountains on the earth’s surface, being no more in comparison of its bulk, than the small protuberances on the skin of an orange: but in another degree of

comparison, some of them display a tremendous magnitude, seeming like mighty columns shooting to the skies. The surface of the earth abounds with great inequalities. In one part of it we behold vast plains intersected by hills and vallies. To another, long chains of mountains, which lift their frozen heads to the clouds ; and betwixt them deep vallies From the bosom of these mountains, rivers spring, which after having watered divers countries, and produced ponds and lakes in several places by enlarging their beds, at length discharge themselves into the sea, and restore to it what it had lost by evaporation.

6. The sea presents us with islands scattered round its coasts, with sands, rocks, currents, gulphs, and storms, and with that regular and admirable motion whereby its waters rise and fall twice in twenty-four hours. The lands and seas are every where replenished with plants arid animals, whose infinitely varied species resort together in every place. Men divided into nations, peoples, and families, cover the surface of the globe. They fashion and enrich it by their various labours, and build habitations from pole to pole, corresponding with their manners, genius, soil, climate. A rare, transparent, elastic substance, encompasses all parts of the earth to a certain height: this substance is the atmosphere, the repository for the winds, the immense reservoir of vapours and exhalations, which being sometimes collected into clouds of a greater or lesser consistence, adorn our element by their forms and colours, or astonish us by their flashes and violent noise; and at other times melting into dews, mists, rain, snow, hail, yield back to the earth what was exhaled from it.

7. The moon, the nearest to the earth of all the planets, is that we have the best knowledge of. Its globe, which is about five and forty times less than ours, always appears to us with the same aspect, because it performs its revolution precisely in the same space of time that it revolves round the earth.

It has its gradual and periodical increase and decrease of light, according to its position with respect to the sun which enlightens it, and to the earth whereon it reflects the light of that sun. The disk of the moon is externally divided into luminous and obscure parts. The former seems analogous to lands on our globe, and the latter to our seas. In the luminous parts there have been observed some places brighter than the rest, which cast a shade from their side, which has been measured and the tract ascertained. These parts are mountains much higher than ours, in proportion to the size of the moon, and whose tops the sun has been seen to gild when that planet is quartered; the light by little and little to the foot of these mountains, they appear at that time entirely bright. Some are by themselves, others form very long tracts .*

Venus has, like the moon, her spots and mountains. So have Mars and Jupiter- Those in Jupiter form large belts, which make considerable motion, like the ocean’s overflowing the lands and afterward leaving them dry on his retreat.

Mercury and Saturn are little known to us; the first, because it is too near the sun, the second, because it is at too great a distance.

Lastly. The sun himself has spots, which seem to move regularly, and whose size equals, and very often exceeds that of such as are seen in the greatest planets.

8. Pure spirits, immaterial and intelligent substances; extensive anti solid substances : mixed beings, formed by the union of an immaterial substance, and a corporeal; are the three general

classes of beings which we have any conception of in the universe. In the universe all is combination, affinity, connexion. There is nothing but what is the immediate effect of somewhat preceding it, and determines the existence of something that should follow It. The Divine Mind has so closely connected every part of his work, that there is not one which has not a relation to the whole system. A mushroom, a mite, are as essential parts of it as the cedar or elephant. So that those minute productions of nature which unthinking men judge to be useless, are not mere particles of dust on the wheels of the machine of the world ; they are small wheels intermixed with the greater.

*It is a serious question, how we can see the body of any orb, through the column of light which is emitted, or reflected from it. When we lose sight of our own at a very small distance, as is instanced in the ascent of balloons, and in the case, when we arc placed many miles distant from the object, does it not at first appear dim, then blue, then of a whitish appearance, &c. In proportion to the degrees of recession, when out at sea, the sailors first descry the distant land, it appears like a whitish cloud just emerging above the horizon. Why do they not see it as plain as when near it Is it not the intervening medium, which intercepts the vision And supposing the eye of the spectator placed at the moon, by what reason, or analogy, could we suppose, that he would there recover the powers of vision, so as to observe the mountains and vallies on the face of our earth which are no more than the small protuberances on the surface of an orange. And supposing him to approach in a direct line from the moon to the earth, would it not appear reasonable to imagine, that the brightness which he would observe at the moon, would diminish as he approximated near, and be reduced, first to whiteness, then to a duller white, then to a grey, then to a blue, until at last he got sight of the earth itself Hence it would appear to be a mistake, to suppose that the powers of vision, aided by the utmost art, are competent to observe any objects the surface of the moon’s body.

There is nothing then by itself. Every being has an activity peculiar to it, determined by the rank appointed for it In e universe A mite is a very small moveable creature, which acts in concert with others, whose activity extends to much greater distances. The sphere thus enlarging themselves more and more, this amazing progressive rises by degrees from the vortex of amber to the solar vortex ; from the sphere of a mite to that of an angel.

9. The elements act reciprocally on each other, according to certain laws which result from their relations; and these relations unite them to minerals, plants, animals, and to men. This last, as the principal trunk, spreads its branches all over the globe.

These species and individuals have relation to the bigness an solidity of the earth. The solidily and size of the earth have relative to the place she occupies in the planetary system. The sun gravitates on the planets; the planets on the sun, and on each other. All gravitate on their neighboring systems ; these or more distant ones; and the balance of the universe remains in equilibrio, in the hands of the Ancient of Days. The human soul, by being united to an organized body, maintain, an intercourse with all nature. From these general principles proceed the connexion of causes and effects, of effects and causes. From hence also arises that indissoluble union which forms, of past, present, future, and eternity, one entire individual whole. The beauty of the world is founded in the harmonious diversity of the beings that compose it, in the number, extent, and quality of their effects and in the degree of goodness arising therefrom.

Chapter 02 - Of the Relative Perfection of Beings

Chapter 2 - Of the Relative Perfection of Beings I. TERRESTRIAL beings may naturally be ranged under four general classes.

1. Brute and organized beings.

II. Organized and inanimate beings.

Ill. Organized and animate beings.

IV. Organized, animate, and reasonable beings.

All beings are perfect, considered in themselves; they all answer one end. The determination or qualities proper for each being, are the means relative to this end. If these determinations should change they would no longer have a reference to their end, and there would be no more wisdom. But those means which are of a more exalted nature, answer a nobler end. T he being appointed to fulfil this end, is enriched with proportionable faculties.

Beings whose relations to the whole are more varied, more multi plied and more copious, possess a higher degree of relative perfects there are two general classes of substances, bodies and souls, there are likewise two general classes of perfection: the corporeal perfection or that which is peculiar to bodies ; and the spiritual perfection, or that which is peculiar to souls.

These two perfections are reunited in every organized animated being, and they correspond with one another. From their reunion proceeds that mixed perfection which answers to the rank every being holds in the system.

2. Of all the modifications of matter, the most excellent is organization. The most perfect organization is that which produces most effects, with an equal or smaller number of dissimilar parts. Such, amongst. terrestrial beings, is the human body. An organ is a system of solids, whose structure, arrangement and action, have motion for their ultimate end, either intestine or locomotive, or feeling. A being, which is barely formed by a repetition of similar parts, enjoys the lowest degree of corporeal perfection. Such probably is the ‘atom or elementary particle. The faculty of generalizing ideas, or abstracting from a subject what it has in common with others, and expressing it by arbitrary signs, constitutes the highest degree of spiritual perfection ; and therein consists the difference between the human soul and the soul of brutes. The soul which is only endued with sense, occupies the lowest degree in the scale. This perhaps is the perfection of the soul of the muscle.

3, The reciprocal action of solids and fluids is the foundation of the terrestrial life. To nourish ourselves, to grow by our food, to beget individuals of cur own species, are the principal ends of the terrestrial life.

If the action of the organs is not accompanied with a sense of this action, the organized being enjoys only a vegetative life. Such is the case of the plant.

If the action of ‘the organs is joined with a sense of that action, the organized being enjoys a vegetative and sensitive life. This is the condition of the brute.

Finally, if reflection is joined to feeling, the being enjoys at the same time a vegetative, sensitive and reflective life. It is man alone upon earth, that unites these three kinds of life in himself. The corporeal and intellectual faculties may be carried to so high a pitch of perfection, in the most exalted order of mixed beings, than we are able to form but faint ideas of them.

4. Between the lowest and highest degree of corporeal and spiritual perfection, there is an almost infinite number of intermediate degrees. The result of these degrees composes the universal chajul This unites all beings, connects all worlds, comprehends all the spheres. One Sole Being is out of this chain, and that is He till made it. A thick cloud conceals from our sight the noblest parts of this immense chain, and admits us only to a slight view of some ill-connected links, which are broken, and greatly differing from the natural order.

We behold its winding course on the surface of our globe, see it pierce into its entrails, penetrate into the abyss of the sea, dart itself into the atmosphere, sink far into the celestial spaces, where we are: only able to descry it by the flashes of fire it emits hither and thither. But notwithstanding our knowledge of the chain of beings is so very imperfect, it is sufficient at least to inspire us with most exalted ideas of that amazing and noble progression and variety which reign in the universe.

5. There are no sudden changes in nature; all is gradual, and elegantly varied. There is no being which has not either above or beneath it some that resemble it in certain characters, and differ from it in others.

Amongst these characters which distinguish beings, we discovery some that are more or less general. Whence we derive our distributions into classes, genera, and species. But there are always” between two classes, and two like genera, mean productions, which seem not to belong more to one than to the other, but to connect them both. The polypus links the vegetable to the animal. The flying squirrel unites the birds to the quadruped. The ape bears affinity to the-quadruped and the man.. But if there is nothing cut off in nature, it is evident that the distributions we make are mother’s. Those we form are purely nominal; relative to our necessities and the bounds of our knowledge. Those intelligences which are superior to us, discover perhaps more varieties between two individuals which we range under the same species,. than we do between two individuals of distant genera. So that these intelligences see the scale of beings all composing one single consequence, which- has for its first term an atom, and, for its last the most exalted seraph.

We may then suppose in the scale of’ our globe as many steps as we know there’ are species. The eighteen or twenty thousand species of plants which compose our herbals, are therefore eighteen or twenty thousand steps of this celestial ladder. And there is not a single plant amongst these, which does not perhaps nourish one or more species of animals. These animals labour or provide nourishment for others in their tarn. They are so many little worlds comprized in others that are still smaller.

Simple produces compound. The molecule forms the fibre, the fibre the vessel, the vessel the organ, the organ the body. The scale of nature then is constructed by passing from that which composes it, to that which is composed by it, from the less perfect to the greater. But while we

‘view it in this light, and in a very general manner, we are not to forget that our method of conception is not the rule of things. We are only to take a transient survey of the exterior parts of beings.

Chapter 03 - A General View of the Gradual Progression of Beings

Chapter 3 - A General View of the Gradual Progression of Beings

1. From the immutability of species amidst the perpetual motion that reigns in the universe, is deduced the indivisibility of the first principles of bodies: and the indivisibility of these principles would demonstrate the simplicity of their nature, if God had not power to render the highly compounded particles incapable of separation. The nature of elementary atoms, their forms, relative proportions, and the manner whereby they effect the formation of bodies, are branches of knowledge that surpass the reach of the human mind. So that we cannot determine whether there are as many species of elements as of bodies; or whether the same elementary particles, variously combined, give birth to different compounded species .*

We are likewise ignorant what it is that essentially distinguishes one body from every other; those we call essential characters are only the ultimate result of the first principles.

0 how interesting would the sight be, were we permitted to penetrate into these principles! A new world would disclose itself to our view; nature then become transparent, would no longer conceal her way from us her laboratories and workshops would then be thrown open. Here we should see her collecting the principles of metals there behold her preparing the colour of the rose. Farther, we-might trace her footsteps into the wonders of light and electricity in other places should observe her sketching the outlines of a plant or animal. Astonished at the sight of this admirable work, we should never be weary of contemplating the infinite diversity of preparations, combinations, and motions, by which it is insensibly brought to its perfection.

*If the elements which constitute the different species of beings, are not simply specific, they must then necessarily be resolved into proportion, which is the same thing; for those proportions will become specific or elementary ratios.

Ye celestial spirits who assisted at the creation of our world, you enjoy these pleasures! Being more favoured than us by time Master of nature, you penetrate into what escapes our notice, and see with': what difficulty we creep from one truth to another, as we observe the efforts of an ape to imitate a man.

2. Observe three principal kinds 'of compositions in terrestrial bodies. 1. That of fluids. 2. That of rude or unorganized solids.

3.That of organized solids. The first genus, which is the most simple, seems to consist in a bare contact of homogeneous particles, which tend to-wards each other; but the least force divides them. The second, which is more compounded, is formed of the union of different particles into a solid mass. The third, still more compounded, is formed of the intermixture of an infinite number of parts, some fluid, and others solid.

3. The small resistance which fluids make to the force that divides-them, their inclination to' a level, the quickness and ease wherewith they move, penetrate, and separate solids, serve to indicate

that they are of all bodies the most simple, subtle, and active.

Fires seems to be a fluid which unites these qualities in the most eminent degree. It is evident from a number of experiments, and particularly from those made by electricity, that fire is a fluid diffused into all bodies, in various proportions. Sometimes it barely fills their pores; at others, is intimately united to their constituent parts, and composes inflammatory matter.

Air and water are likewise contained in the composition of a prodigious number of matters of different kinds. Sometimes they seem to change their nature, and to undergo various transformations ; but these transformations are only imaginary. They resume their primitive state, as soon as the causes which obscured them cease to act.

4. Pure earth is the base or foundation in the' composition of solids. The chemist meets with it in every body he analyzes. Being fixed and unalterable, it will resist the most violent fire; and' this immutability of elementary earth, by convincing us of the simplicity of its nature, shows likewise that it is the first step of the scale of inactive solids.

*Caloric From a mixture of pure earth with oils, sulphurs, salts, &c. proceed the various species of more or less compounded earths, which are the proper nourishment of one part of organized bodies.

Bitumens and sulphurs, which are chiefly formed of inflammable matter and earth, seem to lead us from pure earth to metallic substances, in which we discover the same essential principles, only differently combined. The inalterability of gold from the' most violent tire, its malleability, and prodigious ductility; equally prove time homogeneousness, extreme fineness, and strict union of it parts.

Other metals are ranged after gold, according to the order of their composition or the stronger or weaker combination of their principles. Platina immediately follows gold: and silver also resists the action of fire ; but is less malleable and ductile than gold, and dissoluble by a much greater number of dissolvents.

Copper appears after silver, and has a great affinity to that metal. It is itself succeeded by tin, lead, and iron.

Those compounds which differ from metals, only by their not being malleable, bear a great resemblance to them, and are called demimetals. Such are antimony, bismuth, spelter.

Vitriols, produced by the union of metallic particles with a coagulated acid, seem to be the passage from metallic substances to salts.

Salts, which always affect determinate and constant figures, indicate thereby the invariableness and simplicity of their principles, whose fundamentals are water and earth. When they are dissolved by water, or volatilized by air, they become one of the principle causes of the growth of vegetables as they are of fermentations, whose effects are so various and extensive. The regularity and uniformity of the different kinds of crystallization, sufficiently prove that they are to be attributed to salts, which being dissolved and conveyed by a liquid, and united to foreign matters, compose these pyramidal masses.

Stones, whose species are so numerous, present us with masses of every form, colour, size, and consistence, according to the diversity of liquids, earth, sulphur, metallic parts, salts, places, and other circumstances, which contributed to their formation.

Some of them are perfectly transparent; and these seem to be the most simple. Others are more or less opaque, as their principles are more or less heterogeneous, or more or less mixed.

5. The apparent organization of leafed stones, or such as are divided into layers., as slates, that of fibrous stones, or those composed of filaments, as the amianthus, seem to constitute the passage from rough to organized solids.

We must however allow, that this transition is not so happily' effected, as those we observe in divers other classes of terrestrial beings.

Organized solids are divided into two general classes: vegetable and animal.

It is not easy to determine precisely the distinction between these two classes. We cannot clearly discern where the vegetable terminates, or the animal commences.

Neither the greater or less degree of simplicity in organization, nor the method of production, nourishing, increasing and multiplying, nor the locomotive faculty, sufficiently enables us to distinguish between these two orders of beings.

There are some animals whose structure appears as simple as that of plants.

What the seed and germ are to the plant, the egg and embryo are to the animal. The plant and animal increase in equal proportion by an insensible expansion occasioned by nutrition. The matter received in both of them by inward susception, is there subject to analogous preparations. One part serves as a clothing to the essence of the plant or animal; the rest is evacuated.

There is in plants as well as animals a distinction of sexes; and this distinction in them is followed by the same essential effects that accompany the latter. Several kinds of animals multiply by slips and sprigs; and there are some, that like plants, pass their whole Jives without changing their situation.

If there is any one character, peculiar to the animal, it is that of being furnished with nerves.

6. The plant which seems to occupy the lowest place in the scale of vegetables, is a small unformed mass in which the eye can only perceive a kind of marbling, without any distinct part. This plant is the truffle, the seeds of which are discovered by the microscope. At a small distance from these, is the numerous family of mushrooms and agarics, which would be taken for different kinds of excres tences, were it not that the eye, by the assistance of a glass, can discover flower and seeds in their folds or cavities.

Liverworts, equal in the number of their species to mushrooms, nearly resemble them. They cleave to the surface of stones, dry wood, trees, &c. sometimes like brown spots, at others in pieces of a circular form, of a gray, or yellow colour, composed of small shells or knobs, or notched like fringe, lace, &c. The seeds are contained in small capsules, invisible to the naked eye, as are likewise the flowers.

Mosses seem to be species between the mushrooms and liverworts They delight in shade and moisture, and cling to various sorts of bodies. The filaments which issue from them are often of a cotton like nature, and bear flower and seeds.

7. Plants are of three very distinct sorts. The first, which are for the most part of a small size, delicate constitution, inactive, and abounding in humours, live but a short time; a year is commonly the term of their life. The second, which are for the most part of a gigantic size, robust constitution, hard, and not so full of humours, live many years, and even for several ages. The third bear a mean proportion between the first and second.

Herbs are the first, trees the second, and shrubs the third.

These three kinds which are spread over the face of the earth, live promiscuously therein: but there exists in the different classes, an almost infinite diversity of sizes, forms, colours, and inclinations.

They all in common pass their lives in a state of immoveableness. Fixed to the earth by various sorts of fibres, they derive their principal nourishment from it; and with them to live is to expand them selves.

8. The roots, stalk, branches, leaves, flowers, and fruits, comprise all that is most remarkable in the external parts of plants. The roots, by means of their different kinds of hinges. tuberosities, and ramifications, keep the plant fixed to the earth, while their pores imbibe an exceeding fine slime, which the water liquefies, and carries with it. From the root springs the stalk, to which the plant partly owes its strength and beauty. Being sometimes shaped like a pipe, it is fortified with knots skilfully disposed. As it is sometimes too weak to support itself, it contrives means to twist itself about a solid prop, or to fasten to it by means of the little hands it is furnished with. Otherwise it appears a strong pillar, bears its proud head aloft in the air, and braves the efforts of storms and tempests. The branches shoot forth, like so many arms, from the trunk and stalk, on which they are distributed with great regularity. They are divided anti subdivided into many small boughs, and the subdivisions observe the same order as the principal divisions. The leaves, that charming ornament of plants, are disposed round the stalk and branches with the same symmetry. Some are simple, others compounded, or formed of various foliage. One sort is plain; another indented. Some of them are very thin, others hard, soft, plump, smooth, rough, or hairy. The flowers, whose enamel is one of the principal beauties of nature, are not less diversified- than the leaves. Some have only a single leaf others several. Here it appears like a large vessel opening itself gracefully; there it forms a grotesque figure in imitation of a muzzle, headpiece, or cowl. Farther still, it is a butterfly, a star, a crown, a radiant sun. Some are dispersed on the plant without any art; others compose nosegays, globes, tufts of feathers, garlands, pyramids. The greater part of them are furnished with one or more cups, sometimes simple amid plain, at others consisting of several pieces from the centre of the flower proceeds one or several little pillars, either smooth or channeled, rounded at top, or terminating in a point, called pistils, which commonly encompass other smaller pillars, called stamina. These carry on the upper part of them, a sort of small bladders full of exceeding fine powder, every grain of which, viewed through a microscope, appears of a very regular figure, but varied, according to its species. In some they are small, smooth, globes; in others, they are thick set with prickles like the covering of a chesnut, and sometimes they resemble small prisms, or some other regular body. But how shall we express

their fineness, the lively appearance, delicacy, and variety of shadowings, which accompany, in many species of flowers, the sweetness and agreeableness of the perfume The flowers are succeeded by the fruits and seeds. Magnificent decoration! precious riches, which repair the losses occasioned to plants by the interperateness of seasons, and the necessities of men and other animals.

All fruits and seeds have this in common, they enclose under one of snore coverings the germ of the future plants. Some have only such coverings as immediately enfold the germ, whose outside is of the strongest contexture; and among these, there are some that are provided with wings, tufts, or plumes of feathers, by means of which they are conveyed in the aim or water, by which they are transported and sown in different parts. Others are better clothed, being lodged in sheaths or pods, enclosed in a kind of box, having one or more partitions. A third sort, under a most delicious fruit, which is rendered still more agreeable by its beautiful colour, contain a stone or kernel. Others are enclosed in shells which are either armed with prickles, abound with a bitterjuice, or adorned with fine hair. The outsides of fruits and seeds do not afford less variety than the leaves and flowers; there is hardly any figure whatever, which they do not furnish a representation of.

9. The inside of plants is composed of four orders of vessels, viz. the ligneous fibres, utriculi, or little bags, the proper vases, and the trachea, or air-vessels. The ligneous fibres are very small channels deposited according to the length of the plant, and consist of little pipes placed near each other. Sometimes these vessels are parallel, and at others are separated, leaving between them intervals or oblong spaces.

These spaces are filled by the utriculi, a kind of membranous bladders, horizontally disposed, and which communicate with each other. The proper vases are a kind of ligneous fibres which principally differ from the rest by their juice, which is of a deeper colour or thicker. In the middle of them, or round a great number of ligneous fibres, are some vessels which are not so narrow, composed of a silvery elastic blade, formed spirewise, like a spring; these are arteries. They seldom contain any thing but air.

These four orders of vessels, which are dispersed through all the parts of the vegetable, in proportion to the functions of each, compose. at least in trees and shrubs, three principal beds : the bark, the wood and the pith. The bark, or rind, which is the outer covering of plants, and is smooth, even and shining in some, and rough channeled, and hairy in others, is formed of the widest fibres that are the least pressed together, and which admit within them the most air. The wood, which is placed under the rind, has narrower and more contracted pipes, its utricles less replenished or dilated; and this only has arteries. The pith, which is situated at the heart of the plant, is little more than a collection of utricles, which are greater and more capacious than those of the bark and wood. They diminish and dry up, as the plant advances in age. The simplicity of the organization of vegetables is the principal source, of their different methods of multiplication. A plant pushes out buds from all points of its surface, these buds themselves are plants : being cut and laid in the ground, they take root there, and become entire plants, like that of which they were before only a part. The smallest branch or leaf may give birth to such a whole plant. Suckers taken from the different plants, and ingrafted in the stalk or branches of another plant, incorporate themselves with it, and being united thereto, form one organical body.

10.The timorous sensitive plant flies the hand that approaches her: she closes herself again with the utmost speed; and this motion bearing so great a resemblance to that of animals, seems to constitute one of those connexions whereby the vegetable and animal kingdoms, are united. A little above the sensitive, in a kind of calix, at the bottom of the water, is a small body, exactly resembling a flower. It draws back and entirely disappears when I offer to touch it. It comes out of the calix, and opens itself on my retiring to a distance from it.

While I was endeavouring in vain to account for this, I discovered by the side of it another body of the same form, but larger, and not lodged in an inclosure. It was supported by a small stalk, whose lower extremity joined to a plant, whilst the other, inclining towards the ground, was divided into several little branches.

I immediately believed it to be a parasite plant; and in order to be more fully convinced of it, I cut it in half between its two extremities.

It soon sprouted out again, and appeared the same as before. I stood awhile to consider it. I saw the little branches move, and extend themselves to several inches in length. They are extremely fine, and spread themselves on all sides. A little worm came and touched one of these branches: it presently twisted itself about the worm, and by contracting itself, brought it to the upper extremity of the stalk. There I perceived a small aperture, which enlarged itself in order to receive the worm. It was received into a long cavity that encloses the stalk: being there dissolved and digested before my eyes I afterward saw the remainder go out again at the same opening. The next moment, this singular production separated itself from the plant, and began to walk. The branches after having performed the office of arms, are likewise employed by it instead of legs.

After having made these observations, I could not help acknowledging, that what I took for a parasite plant, was a real animal. I then took a view of the piece I had cut off from it, and perceived, to my surprise, that it had grown, and was become a complete one like the other. But my surprise was greatly increased, when at the end of some weeks I found these animals were transformed into two very small bushy trees. From the trunk, which I knew to be the body of the animal, sprung several branches on all sides of it; from these branches smaller ones sprouted forth; and from those, smaller still. They all move different ways, and stretch out their branches, while the trunk continues fixed to a prop. This surprising assemblage form only one entire body; and the nourishment it receives by one of its parts, is successively communicated to all the rest. In short, this collection of bodies divides itself each piece separates itself from the others, and lives distinctly from them.

Amazed at these wonders, I part one of these animals lengthwise, about the middle of the body, I am presently in possession of a monster with two heads.

I repeat the operation a great many times on the same subject, and by this means I gave birth to a hydra, more astonishing than that of Lerna.

I part several of these animals transversely, and lay the separated pieces end to end. They graft or unite themselves to each other, and compose only one entire animal. To this prodigy I find a new one succeed. I turn one of these insects, as we do a glove, putting the outside within and vice versa. He does not suffer the least alteration from that: he lives, grows, and multiplies.

These animals which multiply by slips and shoots that we engraft and turn inside out, are polypuses.

They are of a very different species. Many of them never shift their places. Some divide themselves lengthwise, and thus make very pretty nosegays, whose flowers are in clusters.

11. There is a wonderful variety in the construction of animal machines. There are some whose number of parts is very small; others, on the contrary, are very much compounded. In some there are only two or three pieces alike ; others exhibit to us a much greater number. In short, the same parts are differently disposed or combined in different machines. The perfection of the machines in nature consists, as in those of art, in the number of parts, and diversity of effects. That is accounted the most perfect, which, with the smallest number of parts, produces the greatest variety of effects. But there is, with respect to ourselves, a considerable difference between the natural and artificial machines : for whereas we may judge of these by an exact comparison of their strength and produce, we can only form our opinion of the others by their consequences.

After this manner we are enabled to judge of the perfection of the human body, from the diversity and extent of the operations of man, rather than from an inspection of his organs, of which we have only a partial view. And if corporeal perfection corresponds with spiritual, as there is reason to believe it does, man, as he is superior to other animals by understanding, so he likewise is by organization. Whence we may infer, that those animals, whose structure most nearly resemble that of men, ought to be considered as the most elevated in the scale.

12. Of all animals that are known to us, the polypus is one whose structure seems to be the most simple, and to come nearest that of plants. This extraordinary animal seems to consist altogether of stomach. His body and arms are composed of one and the same, bowel, whose composition is perfectly uniform. The best microscopes only discover in them an infinite number of small grains, which are tinged with the nourishment the animal feeds upon. Can these grains be so many utricles Can they receive the aliment by immediate conduits, prepare it and transmit it to other vessels appointed to convey it into the channels of circulation Is there a circulation in the polypus The different kinds of vessels which the first conjecture supposes, and which their fineness or transparency may render invisible to must he lodged in the thick part of the texture of the polypus.

We are induced to think so from the experiment of turning it inside out, which being effected, does not cause any change in the vital functions. But of what service can that property be to the polypus, which it cannot make use of without the assistance of man I mean the opera lion of turning the inside outwards.

I answer. that this property is one of the consequences of an organization peculiarly necessary to the polypus. The Author of nature never intended to create an animal capable of being turned as we do a glove: but he designed to form an animal whose principal viscera were lodged in the thickest part of the skin, and which had power, is a certain degree, to escape various accidents to which the nature of its life unavoidably exposed it. Now, what naturally follows from this organization is, the being enabled to endure this shifting without occasioning its death.

13. Those animals whose structure appear less simple than that of the polypus, multiply like him by slips.

These worms have a stomach, intestines, heart, arteries, veins, lungs an] organs of generation. If we look narrowly into the circulation of their blood, we shall perceive its continuance with the same regularity in all those parts which have been separated from the rest by cutting.

These worms bring us to treat of insects.

14. Here we are introduced into a kingdom of animals, the most extensive and diversified of any on the surface of the globe. That province of this vast empire which is seen on the surface of vegetables, is sufficient of itself to attract the curiosity of a traveller, either from the prodigious number of its inhabitants, or the singularity and diversity of their forms.

These are pigmies, the greatest part of which are so minute, as not to be distinctly seen without the help of a microscope. They bear the general name of insects, and this name was given to them on account of the incisions of various depths, by which the bodies of several of then) are divided. The character which seems essentially to distinguish insects from other animals is, that they have no bones. The analogous parts with which some species of them are provided, are placed on the outside of their bodies, whereas, in other animals, the bones are always on the inside.

Life, in insects, does not result from a mechanism as compounded as in the animals of a larger size. In them, the number of different kinds of organs is smaller: but some of these organs seem more multiplied.

Considered in their exterior form, insects may be divided into two classes. The first comprehends insects, improperly so called, whose body is continued; these bear the general name of worms. The second class comprehends insects, properly so termed, whose body is divided by certain incisions or contractions. In the greater part of insects of this class, the incisions separate the body into three principal parts: the head, the stomach, the belly : this division has relation to that observed in great animals. Some of the insects of the first class are without legs: others are furnished with them. All the insects of the second class have legs ; but some are winged, others not.

There is such a diversity in insects, that it may be questioned if there be not united in them every variety to be met with throughout the animal world. And what renders this variety still more surprising is, that it does not extend merely to the whole species, but likewise to individuals. The same insect has at one time organs that are not to be found in him at another. The same individual which in his youth belonged to the first class, in a more advanced age takes up his rank in the second. From thence arise the difficulties attending a proper distribution of these little animals.

15.The bodies of almost all insects are formed of a collection of rings, set in each other, which, by contracting or dilating, lengthening or shortening, contribute to all the motions of the animal. The head, in many species, changes its form in an instant, It contracts and dilates itself, lengthens and shortens, appears and disappears, at the pleasure of the insect. The flexibility of its folds enables it to make these motions. In other species, the head is in one constant position, and bears a greater resemblance to that of the larger animals, by the hardness of its covering, which is scaly. The mouth is sometimes discovered to be a simple circular aperture: but it is generally furnished with hooks, or a kind of pickaxe; with teeth, or two indented shells which they move horizontally; with a trunk, a very compact instrument, which serves to extract and liquefy, and raise up alimentary

juice; or with a sting, which is an organ analogous to the trunk, and endued with the same essential functions.

Several species have two of those instruments united in them, sometimes the teeth and the trunk, and sometimes the trunk and the sting. Many species of insects are deprived of the use of sight. With them the feeling, or some other sense, supplies the defect of eyes. The eyes of insects are of two kinds: the smooth ones are always few in number: the rough commonly amount to several thousands, ,and are fixed on the sides of the head, in the form of two semicircular masses. In both of them they are utterly immoveable.; and. their number compensates in some measure the want of mobility: it is therefore less a mark of perfection than of imperfection. Many species have at the same time two smooth eyes and two rough ones.

Hearing seems to be denied to insects; at least the existence of this sense in them is very doubtful. The case is not the same with respect to smelling. Divers insects have it in an exquisite manner, but the seat of it is not known. May it not be situate in those two moveable horns, called the antenna, whose use we are yet unacquainted with The legs of insects are scaly and membraneous. Those are moved by the assistance of divers articulations, while these, which are more pliable, are turned every way without difficulty. These two sorts of legs are often united in the same worm. Some of them have several hundred legs; but do not on that account walk faster than such as have only six. The wings, which are two or four in number, are sometimes formed of a simple and more or less transparent gauze, and sometimes covered with little scales differently figured; in some they are composed of feathers, as in birds ; in others they are covered, or enclosed in cases. In many species the male is winged, and the female not. On the sides or extremities of the body are little oval apertures. shaped like the ball of the eye, and susceptible of the same motions. These are so many mouths for the purpose of respiration.

16.The interior part of insects contains four principal viscera: the spinal marrow, the intestinal bag, the heart and the tracheal arteries. A blackish thread, which is extended the whole length of the belly from the head to the hinder part, and knit together at certain distances. is the spinal marrow of insects. or the principal trunk of the nerves. The knots placed from one space to another, seem so many particular brains, appointed to distribute the nervous strings to the neighbouring parts, from the action of which the feeling and motion proceed. The first of these knots constitutes the brain, properly so called. On the medullary thread is placed the intestinal bag, which is equal to it in length. It is a long gut, in which are contained the aesophagus, the stomach and intestines.

Along the back, and parallel to the intestinal bag, there runs a long and thin vessel, in which may be perceived, through the skin of the insect, alternate contractions and dilatations. This is the heart, or that part which performs the functions of it. The arterial vessels of insects perfectly resemble those of plants. There is in every part of them the same structure, colour, elasticity, destination, and dispersion through the whole body.

17.Worms, whose bodies are lodged in a crustaceous or stony seem to constitute the connexion between insects and shellfish

There are notwithstanding some shell animals, whose structure with respect to its simplicity, seems to vie with that of the polypus. Of this number is the pond muscle wherein we can discover neither spinal marrow, arteries, veins -nor lungs. Does the scale of nature branch out as it

advances May insects and shell-fish be two parallel branches of this great stem May the frog and the lizard, which bear so near a resemblance to insects, be a ramification of them We are not able at present to answer these questions.

Such is the gradation between beings, that they often differ from each other by slender shadowings; and such is the narrowness of our capacities, that none but the plain and more striking marks attract our notice.

18. The agreeable diversity in the figures of shells, helps us to judge of the variety subsisting in the organization of those animals who are the inhabitants and architects of them. Some consist of one entire piece; others of two or more. Some are formed in imitation of a trumpet, a screw, a tiara, a dial. Others resemble a helmet, a club, a spider, a comb. In this, it is a kind of fleshy case ; in another it is a ship, wherein the sailor is at the same time rudder, mast, and sail.

Animals that have shells, and insects with scales, seem to have an affinity to each other by a common character; both of them have their bones placed on the outside. We may in effect consider the shell as the bone of the animal which occupies it; since he brings it into the world with him, and adheres to it by different muscles. But it is certain that most shells are formed of the stony juices, which transude from the pores of the animal. The bones, as well as the shells of insects, grow and are nourished by vessels which pass through their substance.

Shell-fish form two great families, that of the conche, or larger kind, whose shell is made up of two or several pieces; and that of snails, whose shell consists of one single piece, turned for the most part spirally. The stucture of the first seems much more simple than that of the last. The concha have neither head, horns, nor jaws; one can only observe in them air vents, a mouth, an anus, and sometimes a sort of foot. The greatest part of snails, on the contrary, have a head, horns, eyes, a mouth, an anus, and a foot. The round and fleshy head is at the anterior and upper part of the animal. It contains a brain, composed of two little globes, whose apparatus is of such a moveable nature that it is transferred from the hinder to the fore part, at the pleasure of the snail. The horns, which are two or four in number, placed on the sides of the head, are a kind of pipes, susceptible of various motion, and which the animal can draw into his head by the help of a muscle which the Grand Observer has ordained to perform the functions of the optic nerve. In some species of snails, the eyes are placed at the extremity of the horns, as at the end of the shank of a pair of spectacles. In others at the base, or towards the middle. They are black and brilliant, pretty much resembling the form of a very small onion We can only discover their tunic, which is called the urea; but they have the three humours belonging to our eye. The mouth, which it commonly a small chink, like a furrow, is furnished in many species of them, with two cartilaginous jaws placed on each other, whose inequalities or clefts perform the office of teeth ; some species have, real teeth, like those of a sea-dog, which are extremely small. The shell-fish that have no jaws, have a fleshy or muscular pipe, which supplies the place of a snout.

Snails are not provided with feet; but they have one foot of a particular make, which is nothing more than a collection of a great number of muscles, whose motions imitate those of the waves of the sea. A pretty thin membrane lines the inside of the shell, and sometimes the-outside. It is a kind of mantle, furnished with trachea or air vents, which separate the air from the water, at the origin of which are perceived little gills destined to the same uses. The heart, which is situated near the surface of the body, has a sensible motion, whereby it. raises and falls alternately In the

concha it is underneath the stomach.

19. Animals with shells bear an affinity to fishes. Reptiles seem to take place between or next to them, being united to shelled animals by the slug, and to the fishes by the water serpent. In reptiles, animal perfection begins to increase in a sensible manner. The number of their organs, their conformation and exercise give them, on this account, a greater analogy with the mechanism of those animals we esteem the most perfect. The organs of vision, hearing, and circulation, furnish examples sufficient to indicate -this. This analogy is augmented in fishes. The eel by its formation, and creeping fishes by their method of moving, connect fishes with the water serpent.

20. Fish, like reptiles, are for the most part covered with scales, whose figure and rich colours help to make a distinction between the species.

There is a great variety in the form of fishes. Same are long and slender; others are broad and short. We see among them, flat, cylindrical, triangular, square, and circular ones. Some are armed with a great horn. Others wear a long sword, or a kind of saw. A third sort are furnished with pipes, through which they throw out the remainder of the water they have swallowed. Wings are to birds of the same use as fins to fishes. Some have two or three: others have a greater number. The head of fishes, like that of reptiles, is joined close to the body. The mouth, which is commonly furnished with two or more rows of teeth, is sometimes placed on the back. aw are the eyes. The lungs, which are formed of several blades, of vascular leaves, are often placed at the surface of the body. They are known by the name of gills. But let us avoid anatomical descriptions, which would carry us too far. We shall now confine ourselves to some of the principal varieties, and to the sources of those relations that are more striking.

21. I see the flying-fish dart itself into the air from the bottom of the water, having fins resembling the wings of a bat. Herein it has an affinity to birds. But I see a great animal advancing towards the seashore, having a bead and fore part like a lion, and the hind part resembling that of a fish. It has no scales; and is borne on two paws, that have toes with fins to them. It is called the sea-lion He is followed by the sea-calf, and the hippopotamus or sea-horse, and by all in general of the cetaceous kind. The crocodile and tortoise present themselves to my view in their turn; and I now find myself among quadrupeds. Without presuming to account for the ways of nature, we wifi at present place birds between fishes and four footed animals. In this order aquatic birds are ranged immediately under the flying-fish. Amphibious birds, or such as live both on land and in the water, will occupy the scale next in course, and by this means open a communication between the terrestrial, aquatic, and aerial regions. To this new mansion there is added a new decoration. To scales succeed feathers, which are closer compacted and more varied: a bill takes place of teeth; wings and feet are to them instead of fine; lungs formed within, and a different structure, cause the gills to disappear a melodious song follows a profound silence. Between the cormorant and swallow, the partridge and vulture, the hummingbird and ostrich, the owl and peacock, the raven and nightingale, what a surprising variety is there of structure, proportion, colour, and song

22. I-laity birds, having projecting ears, a mouth furnished with teeth, and whose body is carried on four paws armed with claws, are they birds in reality! Are quadrupeds, that fly by the assistance of great membranous wings, really such the bat and flying-squirrel, are these strange animals, which are so proper for establishing the gradation that subsists between all the productions of nature. The ostrich with the feet of a goat, which rather runs than flies, seems to be another link which

unites birds to quadrupeds. The class of quadrupeds is not inferior in variety to that of birds. These are two perspectives of a different taste, but which have some analogous point of view. Carnivorous quadrupeds answer to birds of prey. Quadrupeds that live on herbs or seeds, answer to birds that live on the same kind of aliment. The screech owl among birds is the same as the cat among four footed animals. The beaver seems answerable to the duck. Quadrapeds may be divided into two principle classes. The first comprehends quadrupeds with a solid foot.The second comprises quadrupeds whose feet are furnished with claws toes. Amongst quadrupeds of the first class, from the stag to the and those of the second, from the lion to the mouse, what a diversity models, sizes, and motions, do we observe! By what degrees does nature raise herself up to man

How will she rectify this head that is always inclined towards the earth How change these paws into flexible arms What method will she make use of transform these crooked feet into supple and skillful bands Or how will she widen and extend this contracted stomach In what manner will she place the breasts, and give them a round suitable to them The ape is this rough draught of man: this rude sketch, an imperfect representation, which nevertheless bears a resemblance to him and is the last creature that serves to display the admirable progressive - of the works of God.

Chapter 04 - Continuation of the Gradual Progression of Beings

Chapter 4 - Continuation of the Gradual Progression of Beings

1. The relations which the plant bears to those beings that surround it, and from whence it derives its substance, are purely corporeal, or comprehended entirely within the sphere of the properties of bodies. The animal, which is more excellent, is allied to nature by other connexions, and by such as are of a more exalted kind. Like the plant, it vegetates: like her, it receives that nourishment from without, which promotes the growth of it; and like her it multiplies. But to those different actions are superadded feeling: or the perception of what passes within him. This sense of feeling is connected with several others, which are produced various ways; and they are all accompanied either with pleasure or pain.

Agreeable sensations inform the animal of the relations which certain bodies have to its preservation or welfare: disagreeable or painful sensations advertise him of qualities which are hurtful. He is then the centre to which diverse objects are directed: he draws near some, and keeps at a distance from others. The nerves, or that cluster of small fibres which extend themselves from the brain to all parts, like small cords, constitute the immediate organ of feeling.

2. Does spiritual perfection always answer to corporeal in animals If this be true, how comes it to pass, that the simple ostrich appears inferior in understanding to the lion pismire, which is placed so much beneath it in respect to structure

Let us not mistake. The marks of understanding exhibited to us in some insects are surprising, inasmuch, as we do not expect to meet with them in those animals we scarce think capable of feeling. Our imagination is warmed, and we ascribe to those insects more genius than they really have. On the contrary, we form high expectations from larger animals; so that we are very apt to degrade them, as soon as we perceive they fall beneath the idea we entertained of them. T here are some. however, whose mind does not display itself by striking marks, but by a great number of less sensible ones, which, being united, form a degree of understanding superior to that of the most industrious insect. Such, without doubt, would appear to be the case of the ostrich, were she better observed. We reproach her, with indifference towards her eggs. It is affirmed, that she leaves the care of hatching them to the sun. This reproach is turned into a commendation, with regard to the ostriches of Senegal, since an exact observer has bestowed on them the attention they require. In these scorching climates, the sun sufficiently heats in the day time, an ostrich’s eggs that are hid in the sand. The warmth of the mother would be then unnecessary, or even hurtful to them: she would keep the sun from them, whose rays are more active and efficacious. But the nights in Senegal are very cool, and the eggs would be in danger of growing cold. Then the mother never fails to procure them heat, by sitting upon them during that time. At the Cape of Good Hope, where it is not so hot as at Senegal, the ostrich sits night and day, like other birds. The young ones peck in a few hours after they are hatched; but they are not able to walk till several days afterward: the dam takes care to place near them such food as is proper for them.

Lastly, it is to be remarked, that there is a kind of society among large animals. Their memory retains faithfully a certain number of signs and sounds. Their soul is affected by a variety of perceptions sight and hearing alone furnish an abundant source to them. Insects afford us but very imperfect images of this. The lion pismire is ignorant of every thing but the snare he has laid, and the prey he expects in consequence of it. His eyes, which are motionless and unmeaning, differ widely from ours; nor is lie affected by any sound.

3. Those are undoubtedly the most perfect animals, whose sphere of understanding extends to the greatest number of objects. These are various in their operations, can shift about and compass their ends by different ways. The polypus only knows how to lengthen and contract his arms. The spider spreads a net with a geometrical regularity. The falcon and dog pursue their prey with sagacity. The ape presumes to imitate man. Has God created as many species of souls as of animals Or is there only one species of soul in animals, differently modified according to the diversity of organization This question is absolutely impenetrable by us. All we can say concerning it is this: if God, who has always acted by the most simple means has thought proper, to vary the spiritual perfection of animals merely by organization, his wisdom has so ordained it.

4. At the submit of the scale of our globe is placed man, the masterpiece of earthly creation. Not to dwell on the excellent construction of his body, let us consider man as an intelligent being. Man is endued with reason ; he has ideas; he compares these ideas together; judges of their relations or oppositions; and acts in consequence of this judgment. He alone, of all animals, enjoys the gift of speech; he clothes his ideas with such signs as he thinks proper: and by this admirable prerogative he forms a connexion between them, which renders his imagination and memory an inestimable fund of knowledge. By this means man communicates his thoughts, and brings all his faculties to a state of perfection: by this he attains to all arts and sciences: and by means of this, all nature is subject to him.

Sometimes, with a strong and harmonious voice, he celebrates, in a poem, the virtues of a hero. At others, by a stroke of the pencil, be changes a dull canvass into a charming perspective. Here we see him with the chissel and graver in his hand, animating the marble, and giving life to brass.. There, with the plummet and square, erecting a magnificent palace. Now we behold him, by a microscope of his own invention, discovering new worlds amidst invisible atoms, or penetrating the secret exercise and motion of particular organ. At other times, by changing this microscope into a telescope, he pierces into the heavens, and contemplates Saturn and his moons. Returning borne, he prescribes laws to the celestial bodies, describes their paths, measures the earth, and weighs the sun. Afterward he dives into the nature of beings, examines their relations, and the admirable harmony resulting from them, and by an attentive view of their various perfections, he sees an immense chain formed,. comprehending the whole. In another station, man is occupied in such arts as contribute to the supply of his necessities, or conveniences. His reason condescends to every thing. The earth, cultivated by his care, teems every year with new productions. Hemp and flax divest themselves of their bark to furnish him with clothing. The sheep abandons for his use his rich fleece, and the silk-worm spins for him her precious wool. The yielding metal is moulded in his hands, The stone softens in his fingers. The largest and strongest trees fall at his feet, and receive from him a new being. All the animals are subject to his Jaws ; even the fiercest of them insult pot his crown with impunity. He makes some serve for food; others be harnesses to his chariot; and others he condemns to till his lands. Many of them he appoints to be his porters,

hunters, guards and musicians. In short, man ploughs his adventurous way across the vast ocean, and by navigation unites the two extremities of the globe.

5. The excellence of human reason shines likewise with a new lustre, from the establishment of societies. In them virtue, honour, fear, and interest, variously employed or combined, prove the source of peace, happiness, and order. All the individuals, being mutually interwoven together, move in a regular and harmonious manner. Under the sanction of the laws, the king, prince, and magistrate, by exercising a lawful authority, promote virtue, suppress vice, and spread around them the happiest effects of their administration. In society, as in a pure and fertile climate, talents of different kinds spring up and infold themselves. From that, the mechanical and liberal arts flourish. Lastly, society perfects friendship, that faithful companion of life, which administers consolation in our sufferings, and gives a relish to our pleasures.

6. The last mark of the greatness of man, and of his high exaltation above other animals, is the commerce he has with his Creator by religion.

Wrapped in the thickest darkness, the rest of the animal creation are ignorant of the hand that created them. They enjoy an existence, but cannot trace the author of life.. Man alone soars to God the principle, and prostrate at the foot of the throne of the Almighty, adores with the profoundest veneration, and with the most lively gratitude, the ineffable goodness that created him. In consequence of those eminent faculties wherewith man is enriched, God condescends to reveal himself to him, and to lead him as it were by the hand in the paths of happiness. The various laws he has received from the Supreme Wisdom, are so many lights placed at proper distances on his road, to guide him from time to eternity.

Enlightened by this Celestial Guide, man advances in the glorious race that is set before him, and seizes the crown of life, and adorns with it his immortal brow.

7. Such is the man in the highest degree of earthly perfection. But mankind have their gradations, as well as the other productions of our globe. There is a prodigious number of continued links between the most perfect man and the ape.

If you take a survey of all the nations of the earth; if you con, eider the inhabitants of the same kingdom, province, city, or town; nay, do but examine with attention the members of the same family, and you will imagine you see as many species of men as you discern individuals.To the Lapland dwarf, let the giant of Madagascar succeed. Let the flat faced African, with his black complexion and woolly hair, give place to the European, whose regular features are set off by the whiteness of his complexion and beauty of his hair. To the filthiness of a Hottentot oppose the neatness of a Dutchman. From the cruef Anthropophagite pass to the humane Frenchman. Place the stupid Uuron opposite the profound Englishman. Ascend from the Scotch peasant to the great Newton. Descend from the harmony of Handel to the rustic songs of the shepherd. Put in the same scale the locksmith constructing a jack, and Vaucannon forming his automatons. Reckon up the number of steps from the smith that causes the anvil to groan, to Reaumor’s anatomizing fire. Do these varieties arise from any real difference there is between human souls, independently of the organization of the body

We shall not think so, if we pay a due attention to health and sickness, to constitution and manner of living, to climate and education.

You may perceive what a multitude of consequences a mathematician derives from a very simple principle: place this same principle in the hands of a man of the lower class, it will remain barren, and. not be productive of the smallest truth. May not the number of just consequences which different minds deduce from the same principle, serve as a foundation for constructing a psychometer upon ; and may we not presume that one time or other we shall be enabled to measure spirits as we now do bodies But the scale of the creation does not terminate at ‘man. Another universe commences there, whose extent, perhaps, compared to that of this, is as the space of the solar vortex to the capacity of a nut.

There shine the Celestial Hierarchies, like glittering stars.

There from all parts the angels, archangels, seraphim, cherubim, thrones, virtues, principalities, dominions, powers, cast forth their radiant beams. In the centre of these august spheres, shines glorious “the sun of righteousness,” the East above, whence all the other stars borrow their light and splendour.

Ye planetary worlds! celestial hierarchies! you sink into annihilation in the presence of the Lord: your existence is by him: “he is that he is :“ He alone possesses the plenitude of being, you enjoy but the reflection of it. Your perfections are streams, the infinitely perfect Being is an ocean, an abyss, which the cherubim presume not to look into.

If we enjoy a very sensible pleasure on seeing collected, in one place, the principal productions of nature, how great must the ecstacy of celestial spirits be, when they survey those worlds which God has thick sown in the vast expanse, and when they Contemplate the immensity of his works

O! the delightful employment those superior intelligencies are exercised in, when they compare the different economies of these worlds and weigh in the balance of reason each of these globes! But all celestial intelligence, doubtless enjoy not these advantages in the same degree. There may be some perhaps to whom is granted the knowledge of one world only: others may know several: others a much greater number flow immense must that mind be, which beholds with a single glance the sum of all beings, and which by fathoming the spirits of all orbs, discerns in an instant, and without confusion, the result of all the ideas that have, do now, and will hereafter occupy them.

Ye inhabitants of the earth, who have received reason sufficient to convince you of these worlds, will you for ever be denied entrance into them will the infinitely good being, who shows them to you at a distance, always refuse you admittance into them No; since you are called to reside ere long among celestial hierarchies, you will like them fly from planet to planet; you will eternally advance from perfection to perfection, and every instant of your duration will be distinguished by the acquisition of farther degrees of knowledge. Whatever has been withheld from your terrestrial perfection, you will obtain under this economy of glory; “you will know even as you are known.”

“Man is sown corruptible, be will rise incorruptible and glorious :“ these are the words of the apostle and philosopher: the covering of the seed perishes; the germ subsists, and assures man of immortality.

Man therefore is not in himself what be appears to be. What we discover in him here below is only the gross foldage under which he crawls on the earth, and which he must shortly cast off. The brain is a small organical machine, destined to receive the impressions made on the different parts

of the body, and to transmit them to the soul. it is by means of this that the soul acts on various points of the body, and adheres to nature. The extremities of all the nerves, radiate to the seat of the soul it is in some measure the centre of this admirable collection, the threads of which are so numerous, fine, delicate, and full of malion. But the nerves are not stretched like the strings of an instrument of music. Animals that are entirely glutinous, are notwithstanding very sensible.

We then admit there is a fluid in the nerves, whose subtilty prevents our seeing it; and which serves both for the propagation of sensible impressions, and muscular motion. The instantaneousness of this propagation, and some other phenomena, indicate that there is a certain analogy between the nervous fluid and fire or light.

We know that all bodies are impregnated by fire. It abounds is aliment. It is extracted front it by the brain, from whence it passes Into the nerves. The seat of the soul, the immediate organ of feeling and thought, can be no other than a composition of this vital fire. The brain, which we see and feel, must therefore only be the case or covering of the ethereal machine, which constitutes the real seat of the soul.

It may indeed be the germ of that spiritual and glorious body, which revelation opposes to the animal and vile. The resurrection, then, will only consist in a prodigiously rapid unfolding of this germ, which lies hid in the brain.

These senses are the foundation of those relations which the animal body bears to terrestrial bodies. The seat of the soul, or the little ethereal machine that constitutes it, has parts corresponding with the grosser, since it receives motions from thence, and transmits them to the soul. These parts, by the opening of the germ, will require a degree of perfection incompatible with the present state of mans But this germ may likewise contain within it new senses, which will disclose themselves at the same instant, and by multiplying in an almost infinite degree the relations of man to the universe, will aggrandize his sphere, and render it equal to that of superior intelligences. An organized body, formed of elements analogous to those of light, will, we may reasonably suppose, stand in need of no repair. The spiritual body will preserve itself by the mere energy of its mechanism. And if light or ether do not gravitate at all, man in a glorified state will be enabled to transport himself at pleasure into every point of space, and will fly from planet to planet, with the swiftness of lightning. The senses, as they will then be brought into subjection to the soul, will no longer rule over her. Separated for ever from flesh and blood, there will remain in her none of those earthly affections which resulted from them. Transported into the regions of light, the human understanding will present no ideas to the will but those of the highest good. It will then have no other than lawful desires, and God will be their constant and ultimate end. It will love him from gratitude; fear him from a principle of love; and will adore him as the supremely amiable Being and as the eternal source of life, perfection and happiness.

Chapter 05 - Of the Various Relations of Terrestrial Beings

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1.We have seen, that all is relation in the universe, but we have only hitherto taken a distant view of this fruitful truth. We may now approach nearer to it, and bestow our attention on the most interesting particulars. The union of souls to organized bodies, is the source of the most abundant and most wonderful harmony that exists in nature. A substance without extension, solidity and form, is united to an extended, solid and formed substance. A substance that thinks, and which has a principle of action in it, is united to a substance void of thought and purely passive. From this surprising connexion there springs a reciprocal commerce between the two substances:, a kind of action and -reaction, which constitutes the life of organized, animated beings. The nerves, being variously agitated by objects, communicate their motions to the brain, and to these impulses the perceptions in the soul correspond, which are totally distinct from the cause that occasions them. The rays which proceed from an object strike my optic nerve. I have a perception that points out to me the presence of the object. They affect this nerve in a violent manner: I have a sensation which I express by the term of pain. The diversity of senses by which the soul receives the impression of objects, produces a diversity in her perceptions and sensations, The sentiments occasioned by the motion of the nerves of sight, differ absolutely from those that are produced by that of the nerves of bearing. The sense of feeling has no likeness to that of taste. These are different modifications of the soul, which correspond to different qualities of the objects. But how can the nerves, which do not seem susceptible of a greater or less degree of bulk, length, composition, or tension, or of quicker or slower vibrations, occasion in the soul such a prodigious variety of perceptions as we experience Is there such a relation between the soul and the machine to which it is united, as for certain perceptions- to correspond continually with the nerves of a determinate size, structure, and tension Are there nerves appropriated to different corpuscles, to the impression whereof various perceptions are attached Are the pyramidial form of the papillae of the taste anti feeling, the winding cavities of the ear, the different refrangibilities of the- rays of light, so many proofs of the truth of this Be that as it may, we are sufficiently convinced that the same sensible fibre is not liable at one and the same time to a multitude of different impressions. But this fibre is not only destined to transmit to the soul the impression of the object; it must also preserve the remembrance o it; for a thousand instances prove that the memory is connected with the brain; how then can it be imagined that the same fibre should at once retain a multitude of different determinations Nay, how can two such different substances as the soul and body act reciprocally on each other At this question let us humbly cast our eyes down. wards, and acknowledge this is one of the great mysteries of the creation, which we are not permitted to be acquainted with. The various attempts that have been made by the most profound philosophers, to explain it, are so many monuments raised to convince us both of the extent and weakness of the human mind.

2. The soul, being modified by impressions more or less strong, reacts in her turn on the nervous system, maintains the motions there, and renders them more active or durable. From thence arise the passions, those secret inclinations, those restless appetites, which destroy the equilibrium of

the soul, and impel her towards certain objects. These are admirable instruments set to work by the wise Author of our nature; which like favourable winds, cause the animated machines to float on the ocean of sensible objects. The reaction of the soul on the nervous system, seems also to-be the principal source of divers sensations we experience, several of which come under the denomination of instinct, or moral sense.*

Objects do not strike immediately on the soul. She only receives impressions by interposed mediums. The senses are the mediums. The action of objects, then is modified-by them in a determinate relation, to nature, or to the constitution of each medium. The aptness, either greater or less, wherewith sensible fibres yield to impressions from without, transmit them to the soul arid renew the remembrance of them there, together with the quality, and abundance of' the humours, constitutes the temper. In animals, temper governs all. In man, reason regulates the temper: and the temper, when under due regulation, facilitates, in its turn, the exercise of reason. The passions receive nourishment, grow and become strong like the fibres, which are the seat of them. Learn then your temper, if it be vicious, you are to correct it; not to destroy it, for you would thereby destroy the machine itself; but skilfully to divert its course, and carefully to avoid every thing that may contribute to add new strength to it, and swell the waters of such a dangerous torrent.

*The doctrine of the action and reaction of the nervous system, appears to accord with the universal scheme of nature. We discover no process, without a recess; no consequence, without an antecedence; and no state or condition of being, without an abstract; a-s the ethereal appears to be the abstract of the terrestrial state of being: and death the abstract of life. And all the various phenomena we observe in nature, appear to originate in the various modes by which material bodies pass to the alternate states of being.

3. The senses are not only intended to raise in the soul perceptions of every kind; they likewise -revive memory in her. A perception which is present to the memory does not essentially differ from that which the object excites. This produces perception by means of sensible fibres appropriated to it, and on which its action is displayed. The collection of perception then depends on a motion which operates in these fibres, independently of the object. For whether the organ receives its motion from intestine causes, or from the object, the effect is the same with regard to the soul, and perception is instantly present to her.

Experience proves, that if any series of perceptions whatever affects the brain for a certain time, it thereby contracts a habit of reproducing it in the same order. It is likewise certain that this habit appertains to the brain, and not to the soul. A burning fever, a ray of the sun, or a violent commotion may destroy it, and such causes influence only the machine.

All perceptions derive their origin from the senses, and the senses transmit to the seat of the soul, the impressions they receive from objects. ‘But objects act on the organ by impulsion only. They impress then certain motions on the sensible fibres. So that a perception, or a certain series of perceptions, are connected with one or divers motions which -operate successively on different fibres. And since the reiteration of the same motions, on the same fibres, effects in them a habitual disposition -to produce them afresh in a constant order, we may infer from thence, that the sensible fibres are so constructed as to produce in them changes or determinations more or less durable, which constitute the precious ground-work of the memory and imagination. But the sensible fibres are nourished like all the other parts of the body; they assimilate or incorporate with

themselves -alimentary matter: they grow, and whilst they receive nourishment, they continue to perform their proper functions. So that ‘nutrition conduces to preserve to the fibres these determinations, and causes them to take root there: for as the fibres increase, they acquire a greater degree of consistence. We may hence discover the origin of custom, that powerful queen of the sensible and intelligent world. The memory, by preserving and recalling to the soul the signs of perception, by assuring her of the identity of the perceptions recalled, and of those which have already affected her, by connecting present perceptions with the antecedent ones, forms in the brain a fund of knowledge, which increases in richness every day. The imagination, being infinitely superior to a Michael Angelo or a Raphael, delineates in the soul, a faithful image of objects; and from divers representations which it composes, forms in the brain a cabinet of pictures, every part of which moves-, and is combined with an inexpressible variety and swiftness. The brain of man, then, may be considered as so many mirrors, wherein different portions of the universe are painted in miniature. Some of these mirrors exhibit but a small number of objects; while others represent almost the whole of natures What is the relation between the mirror of the mole and that of a Newton! What images were there in the brain of a Homer, a Virgil, or a Milton What mechanism must that have been which could execute such wonderful decorations! That mind which could have read the brain of a Homer, Would have there seen the Iliad represented by the various exercise of a million of fibres.

4.Of all the senses, the sight Is that which furnishes the soul with the quickest, most extensive, and most varied perceptions. It is the fertile source of the richest treasures of imagination, and it is to that principally that the soul owes the idea of beauty, of that varied unity Which ravishes it But by what secret mechanism are my eyes made capable of communicating to me such lively, varied, and abundant perceptions How do I discover with so much ease and quickness every object that surrounds me

Three humours of different density, each lodged in a transparent capsule, divide the inside of the globe of the eye into three parts, On the bottom is spread a kind of cloth, or very fine membrane, which is only the expansion of a nerve, whose extremity terminates immediately at the brain. A black skin lines the whole inside of the globes At the forepart of it is a round orifice, which contracts or dilates itself according as the light is more or less strong. Six muscles, which are placed on the outside of the globe, move different ways, end the rapidity of those motions is excessive4

What need is there of these humours, this cloth, this tapestry, this’ aperture which contracts and dilates itself The light comes to us from the sun In a right line: but these rays become crooked, when the density of the mediums through which they pass increases or diminishes. This is called the refraction Of light. To the property of refracting light, joins that of reflecting from the body it enlightens. There issue then luminous streaks from all points of the objects, which bear the image of’ these points. The humours of the eye are the lens of the camera obscura: the cloth or retina are the pasteboard. The black skin which hangs Within the ball performs the office of a shutter that excludes the light it extinguishes the rays whose reflection would render the image less distinct; the ball by contracting or dilating itself in proportion to the strength of the light, moderates the action of the rays on the retina: the nerve placed behind this, communicates to the brain the various concussions it receives, to which divers perceptions correspond.

Such are the admirable relations which wisdom has placed between our eyes and the light: those which it has established between light and the surface of different bodies, whence colours proceed, arc not less worthy our attention. A ray which foils on a glass prism, divides into seven principal rays, each of which bear its proper colour. The oblong image which this refraction produces, affords several coloured stripes, distributed in a regular order. The first, reckoning from the upper part of the image, is red; the second, orange; the third, yellow; the fourth, green; the fifth, blue; the sixth, indigo; the seventh, violet. These stripes do not glare: But the eye passes from one to the other by gradations or shades.

The rays which bear the highest colours, as the red, orange and yellow, are those that refract or curve the least in the prism. They are also such as reflect the first, on inclining the instrument. From thence it follows, that each ray has its fixed degree of refrangibility. Make one of these rays pass through several prisms at the same time, it will afford you no new colours : but it will constantly retain its primitive colour; which is an invincible proof of its immutability. Present a lens to seven rays-divided by the prism, you will reunite them into a single ray, which will afford you a round image of a shining white. Take only five or six of these rays with the lens; you will have but a dusky white. Only reunite two rays; you will make a colour, that will partake of both. A stream of light then is a cluster of seven rays, whose reunion forms white, and the division of which produces seven principal and immoveable colours!

What is now the source of that infinite diversity of colours, which embellishes every part of our abode The particles which compose the surface of bodies, are so many little prisms variously inclined, which break the light, and reflect different colours. Gold divided into very thin plates appears blue, when opposed to broad daylight. The greater or less thickness of the plates contributes them to the diversity of colours. Whence proceeds that beautiful azure which tinges the canopy of heaven The ground of the heavens is black; this ground viewed through the body of air which surrounds us, must appear blue to us. Whence proceeds this smiling verdure which adorns our fields The lamellae of the surface of plants are disposed in such a manner, that they remit only green rays, whilst they afford a free passage to others. If green pleases our sight, it is because it holds precisely a medium between the seven principal colours. But who can remain insensible of the care which nature has taken to depart from uniformity in this case, by multiplying in so great a degree the shades of green You may admire this magnificent rainbow, which delineates at large to you the colours of the prism: the beauty and vivacity of its shades ravish you: you suspect that nature must have been at vast expense to compose this rich girdle. Some drops of water, on which the light breaks and reflects in different angles, are the sole cause of it.

You are struck with the splended gilding of some insects: the rich scales of fishes attract your notice: nature who is always magnificent in design, and frugal in execution, produces these brilliant decorations at a small charge; she only applies a brown, thin skin on a whitish substance: this skin performs the office of varnish to our gilded skins ; it modifies the rays which issue from the substance it covers. The glossy green of the leaves of plants is owing to the same art. They owe their lustre and shades to a fine, smooth, transparent, glossy, and whitish membrane, which clothes a substance that is always of a rough green, and of a stronger or fainter dye. It is this green, modified by this membrane, which constitutes the colour peculiar to leaves of every species.

It is apparently the same with regard to the enamelling of flowers and perhaps likewise to the colouring of fruits. This is a new branch of optics, which were it dived into as it deserves, might be attended with some interesting consequences. The direct light of the sun, or that of the day only, tinges the leaves, as it colours that of fruits. Leaves, whilst they are enclosed within the bud, are whitish or. yellowish. They preserve this colour, if obliged to grow in a tube of blue paper, where the air and heat may have free access. The plant then stars, as the gardeners term it, sending forth an excessively long and slender stalk, and the leaves unfold themselves, but very imperfectly. The light is in a continual and very rapid motion: it acts perpetually on the surface of bodies, which it penetrates more or less. By its small reiterated strokes on leaves, it modifies the surface of them by little and little, and insensibly disposes it to reflect the green colour.

Colours then in objects are only a certain disposition of parts totally distinct from the perceptions which they cause in the soul. It is the same with respect to all our perceptions and sensations. The senses, by presenting to us bodies under different appearances, show us their various qualities; and to these qualities different ideas in the soul correspond. We conclude from hence that the same objects do not affect all sensible beings in an equal manner. It is even doubtful whether two individuals of the same species have precisely the same perceptions in presence of the same object. Were we to contemplate the world by the organs of all those sensible beings which inhabit it, we should perhaps see as many worlds we should employ glasses. What difference would there appear in the mulberry tree, examined through the organs of a silk-worm, from our conception of it! What diversity between the stamina viewed through the eyes of bees, and those which the botanist observes! How extensive would be the knowledge of that being,. who could be acquainted with all these different impressions.*

6. The subtle matter of fire, which is dispersed through all nature, offers to us an infinity of properties: let us confine ourselves to give an account of the most interesting. This matter being subtle, elastic and continually agitated, penetrates all bodies. It warms, dilates, burns, melts, calcines, vitrifies, volatilizes, and dissipates them, according to the nature of their composition or principles. This subtle element becomes visible only by borrowing a body. It secretly

*This is an elegant index; and well calculated to impress on the mind, the important necessity of making all reasonable and liberal allowance, among men of different sentiments for difference of capacity and perception; and it may be further remarked, that all degrees of excellence, of space, of magnitude, of quantity, and of quality, exist by comparison, and all comparison by degrees of sensibility; hence we are taught that different sentiments will necessarily-occur, even among honest men, from difference of impression, and difference of capacity. Could we conceive with the organs of an ephemeron, a single leaf would become a spacious world, interspersed with mountains and valleys, and seem almost of boundless extent; the magnitude of objects, and the extent of space, being proportioned to the powers of conception; and these powers not-only vary in different beings, but they are liable to vary in the same individual with different circumstances. most striking illustration of this fact we have in the instance of the aged prisoner, who groaned in confinement forty-seven years, between four thick and cold stone walls, in that miserable monument of superstition and despotism, the Bastile; and who was released by the clemency of the new administration, upon the accession of Louis XVI. to the throne of France. Hardened by adversity, which strengthens both the mind and constitution, when they are not overpowered by it, he had resisted the horrors of his long imprisonment, with an invincible and manly spirit: his locks

white, thin, and scattered, had almost acquired the rigidity of iron; whilst his body environed for so long a time, by a coffin of stone, had borrowed from it a firm and compact habit. The narrow door of his tomb, opened not as usual, by halves, and an unknown voice announced his liberty, and bade him depart. Believing this to be a dream, he hesitated ;- but at length rose up and walked forth with trembling steps, amazed at the space which he traversed. The stairs of the prison, the halls, the court seemed to him vast, immense, and almost without bounds. He stopped from time to time, and gazed around him like a bewildered traveller, his vision was with difficulty reconciled to the clear light of day. He contemplated the heavens as a new object. His eyes remained fixed, and he could not even weep. Stupified by this newly acquired power of changing his position, his limbs, like his tongue, refused in spite of his efforts, to perform their office. His sensibility was changed by long habit, and he had acquired an en new conception of objects; hence it is manifest, that different sensibilities can originate in different circumstances. 1-fence we may admire the flexibility of the mind, the force of education, and the power of habit. unites, itself to an inflammable and unknown substance, and, provided with this body, unites itself to other bodies, and enters into their -corn; position. It is by means of the same union that it becomes Sensible in electrical experiments sometimes in the form of liminous tufts, sometimes in that of crowns, flashes, sparks, and that it fulminates. bursts, strikes, pierces, burns, inflames. By a gentle agitation, this matter enlivens all organized bodies, conducts them by degrees, to their perfect growth. it foments the branch in the bud, the plant in the grain, the embryo in the egg. It gives suitable preparations to our food. It subdues metals to our use, over the formation of which it presides. By that we are enabled to give matter all those forms which our necessities or conveniences require. To that we are indebted, in a particular manner, for that transparent matter, which being stretched out into thin leaves, or fashioned like tubes, vases, globes, lenses, furnishes us with various instruments, and enriches us with new eyes, which help us to disco ver- the smallest objects, and bring nigh to us the most remote. From the action of this matter on earth, sulphur, oils, and salts,. ‘the various species of fermentations and mixtures result, which are the objects of the researches of the chemist, and the soul of the three kingdoms. Being concentered by lenses or mirrors of every kind, it acquires, a strength greatly superior to. that of the hottest of our actual fires, and in an instant reduces green wood to ashes, calcines stones, melts and vitrifies metals, Being excited, collected, condensed, modified, extracted, directed, and applied by electrical machines, it becomes the fruitful source of a thousand phenomena, which art diversifies every day. Sometimes, when extracted from a globe of glass, it runs with an inconceivable rapidity along an iron wire, and causes light bodies, placed at a league distance from the globe, to feel the impression of it. Applied by the same means to paralytic limbs, it restores life and motion to them. Being present in all parts of the atmosphere, it collects itself in stormy clouds, from whence it is again extracted by art; and a Le Monnier, equal to the fabulous Jupiter, holds the thunderbolt, and dis. poses of it at his pleasure. It is likewise fire that communicates to air and water, when reduced into vapours, that prodigious force which renders them capable of shaking the earth, and breaking the hardest bodies.

Lastly, it is this subtle ‘matter, that by penetrating fluids, preserves to them their fluidity. As it is exact itself; in putting itself in equilibria, it passes from those bodies where it is most abundant, to those where it is least so, and carrying with it the most volatile particles, it deposits them on the surface of the latter, where they appear in the form of vapours, exhalations, or mists.

7. The air, by its fluidity thinness weight, and spring, is next to fire, the most powerful agent in nature. It is one of the great principles of the vegetation of plants, and of the circulation of liquors in all organized bodies. it is the receptacle of the particles which exhale from different matters: and had we eyes sufficiently piercing, we should see it in the abridgement of all the bodies that exist on the surface of our globe. From vapours and exhalations which it carriesits bosom, and disperses into all parts, are produced aqueous and fiery meteors, which are so useful, but sometimes dreadful. The air does not only receive bodies: it even enters into their composition. When divested of its elasticity, it unites itself to the particles which compose them, and augments their bulk. But being more unalterable than gold, it resumes its former nature, when these bodies change or are dissolved.. Being disturbed in its equilibrium, it swells the sails of our ships, and conveys to our countries those rich fleets that cause plenty. becoming impetuous, it causes tempest and hurricanes; but even this impetuosity is not without its use ; the air by this means divests itself of noxious vapours, and the waters being strongly agitated, are preserved from a fatal corruption.

Lastly, the air is the vehicle of sounds and odours, and under these new relations it is essentially allied to two of our senses. The partial vibration which commotion excites in a sonorous body, communicates itself to all the globules of air that immediately encompass this body. These globules cause the like vibrations in those contiguous to them: and this continues in the same manner to greater distances than we are able to determines A fine and elastic- membrane, spread at the bottom of the ear like the parchment of a drum, receives these concussions, and conveys them to three small bones placed end to end, that communicate them in their turn to certain bony and winding cavities, lined on their inside with nervous filaments, which join to the brain by a common trunk. The greater or less degree of swiftness of these vibrations produces seven principal tones, analogous to the primitive colours. From the combined relation of various tones, harmony proceeds. The infinitely small particles that are continually detached from the surface of odoriferous bodies, float in the air, which transports them every where, and applies them to the nervous membranes that are distributed in the inside of the nose. The concussions which these corpuscles occasion therein, pass afterward to the brain by the lengthening of the nervous filaments.

8. All climates have their productions : all parts of the earth their inhabitants. From the frozen regions of the bear, to the burning sands of the torrid zone, all is animated. From the top of the mountains, to the bottom of the vallies, every thing vegetates and respires. The waters and the air are peopled with an infinite number of inhabitant, Plants and animals are themselves little worlds that-nourish a multitude of people, as different from each other in their figure and inclinations as the great people which are scattered over the surface of our globe. What am I saying The smallest atom, the least drop of liquor are inhabited. Wonderful harmony, which by thus suiting ‘different productions to different places, leaves none absolutely desert!

9. A reciprocal commerce connects all terrestrial beings. Inorganized beings answer to organized as to their centre. The latter are designed for each other. Plants are allied to plants. Animals to animals. Animals and plants are linked together- by their mutual services. Behold how closely this young ivy entwines itself round this majestic oak. It draws its substance from it, and its life depends on that of its benefactor. Ye great ones of- the earth, ye represent this oak! Refuse not your support to the indigent: suffer them to approach you, and to obtain from you sufficient to

relieve their necessities.

Consider this caterpillar thick set with hair, the birds dare not touch it, notwithstanding which, it serves them for food: by what means A fly pierces the living caterpillar. She lays her eggs in his body. The caterpillar remains alive. The eggs hatch. The young ones grow at the expense of the caterpillar, and are afterwards changed into flies, which serve for sustenance to the birds.

There are continual wars betwixt animals, but things are so wisely combined, that the destruction of some of them occasions the preservation of others, and the fecundity of the species is always proportionable to the dangers that threaten individuals.

10.All is metamorphosis in the- physical world. Forms are continually changing. The quantity of matter alone is invariable. The same substance passes successively into the three kingdoms. The -same composition becomes by turns a mineral, plant, insect, reptile fish, bird, quadruped, man. The organized machines are the principle agents of these transformations. They change or dissolve all matters that enter within them, and that are exposed to the action of their secret springs. They, convert some into their own substance; others they evacuate under livers forms, which render these matters proper for entering into the composition of different bodies. Thus, animals that multiply prodigiously, as some species of insects, have perhaps for -their principal end that of metamorphosing a considerable quantity of matter, for the use of different compounds. By that means the vilest matters give birth to the richest productions: and from the bosom of putrefaction there issues the finest flower, or the most exquisite fruit! The author of nature has left nothing useless. What is consumed of the dust of the stamina in the generation of plants, is very trifling, if compared with the quantity each flower furnishes. Wisdom itself has then created the industrious bee, that makes use of the superfluous part of this dust with such art and economy as could not be too much admired in the most skilful geometricians The earth enriches us every day with new gifts, whereby she would at length be exhausted, if what she supplies us with were not restored to her. By a law, which we do not pay a proper attention to, all organized bodies become uncompounded, and insensibly change in the earth. Whilst they suffer this kind of dissolution, their volatile parts pass into the air which transports them every where So that animals are buried in the atmosphere as well as in the earth arid water; we may even doubt whether that portion which the air receives be not the most considerable in bulk. AU these particles dispersed here and there, soon enter into new organical wholes, destined to the same revolutions as the former. And this circulation, which has subsisted from the beginning of the world, will continue as long it endures.

Chapter 06 - Of Vegetable Economy

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1. There is no source of physical relations that is more abundant than the economy of organized bodies. Let us cast an eye on what it offers to us on the most interesting nature. Our plan does not lead us to dive into a subject that exhausts the sagacity of a philosopher.

Organical economy, taken in the most extensive sense, is that system of laws according to which the vital functions operate in Organized bodies.

Considered in a less view, organical economy presents us with two classes of objects. The first comprehends the structure, arrangement, and exercise of the different parts of organized bodies. The second comprises the various effects that result from organization.

2. The plant vegetates, is nourished, grows, and multiplies. The saline, unctuous, and subtile slime, which the water separates from the coarse earth, and keeps in a dissolved state, is the principal nutriment of plants.. T he different species of manure only contribute to the fertilizing of land, in proportion, as they introduce into it a great quantity of a spongy powder, or active salt. If a natural philosopher succeeds in raising plants, and causing them to. bear flowers and fruits in other matters than earth, for- instance, in the powder of rotten wood, deal, saw-dust, very fine sand, moss, cotton, paper. sponges: the reason is, because several of these matters either change insensibly in the ground, or actually contain earthy parts, or the water which moistens them is itself charged with these particles, which the organs extract, prepare, and assimilate.

After having been admitted into the body of the root by the extremity of the fibres, the nutricious juice rises into the ligneous fibres, from the trunk or stalk, and passes into the utricles that adhere to them. it is there prepared and digested. It afterward enters into the proper vessels, under the form of a coloured fluid, more or less thick, which we may conjecture to be with respect to the plant, what the chyle or blood is to the animal. Being filtered by finer or more winding pipes, it is at last conveyed to all the parts, whereto it unites itself, and increases their bulk. The extreme fineness of the canals for the sap, which renders them in some measure capillary pipes, the action of the air on the elastic sheaths of the air-vents, and the impression of these last on the ligneons fibres their contain, or by which they are comprised, the heat that rarefies the sap, and above all, that which, by acting on the surface of the leaves, draws thither the superfluous nutricious juice, and occasions the evaporation of it, seem to be the principal causes of the ascent of this fluid in plants. The quantity of nutriment, which a plant derives from the earth is in proportion to the number and size of its leaves; the smaller or fewer in number the leaves are, the less it draws. The nutrition of vegetables is likewise effected immediately by their leaves. They (10 not only serve for raising the sap, preparing it, and discharging its superfluity; they are moreover a kind of roots that pump from the air the juices they transmit to the neighbouring parts. The dew, which rises from the ground, is the principal foundation of this aerial nourishment. The leaves present it to their inferior surface, which is always furnished with an infinite number of small pipes that are always ready to

absorb it And that the leaves may receive no prejudice in the exercise of this function, they are disposed with such an art on the stalk and branches, that those that immediately precede do not cover such as succeed them. Sometimes they are placed alternately on two opposite and parallel lines. Sometimes they are distributed by pairs, that cross each other at right angles Sometimes they are ranged on the angles of polygons circumscribed on the branches, and so disposed that the angles of the inferior polygon correspond with the sides of the superior. At other times they ascend the whole length of the stalk and branches on one or more parallel spital lines.

Ye skeptics, can you inform me why plants are disposed with so much art! You will perhaps deny that plants imbibe the dew by their inferior surface! But what would you say, were one to inform you that among leaves exactly resembling each other, and taken from the same tree, such as have been steeped by their inferior surfaces in vessels of water, have continued green for the space of whole weeks, and. even months; whilst those that have been placed, by way of experiment, with their upper surface in (he water, perished in a few days

Herbs that are always immersed in the thickest beds of dew, and that grow much faster than trees, have their leaves formed in such a manner, that they pump in the moisture nearly alike by both surfaces, sometimes more copiously by the upper ones.

Observe, lastly, that the inferior surface of the leaves of trees is commonly less smooth and glossy and of a paler colour than the opposite -surface. This remarkable difference between the two -sides of the leaf, sufficiently indicates that they have different uses.

3. By a mechanism which is very simple, the root forces itself into the earth; the branches shoot out on each side; the leaves expose their superior surface to the open air, and their inferior surface to the earth, or the inner part of the plant. Sow a seed the contrary way; you will observe the radicle and little stalk to bend backwards; the former in order to reach the earth, and the latter to gain the air. Keep a young stalk inclined; its extremity will grow upwards. Bend the branches of all sorts of plants; cause the inferior surface of their leaves to turn toward the sky; you will soon perceive that all these leaves will turn back again, and resume their former position: which motion will be executed with a quickness proportionate to the heat of the sun, or suppleness of the leaves. Sow different kinds of seeds in a closet or cellar: carry thither some small twigs having their extremity steeped in vessels fiffi of water. The leaves of the young plants and -those of the twigs, will incline their upper surface to the windows or air-holes.

Consider the leaves of divers species of herbaceous plants; of the mallow for instance; you will remark that they follow the course of the sun. In the morning you will see them present their upper surface to the east; towards the middle of the day this surface will face the south: in the evening it will, be turned to the west. At night or in rainy weather these leaves will be horizontal, their inferior sur face looking towards the earth.

Trace likewise the leaves of the acacia; as soon as they are heated by the sun, you will observe all their foliages draw together by their upper surface. They will then form a kind of gutter turned towards the sun. In the night. or in moist weather you will see the foliage turned the contrary way, and contracting themselves by their inferior surface. They will then form a gutter that will face the earth.

4. Do not seek for circulation in plants: as they are more simple than animals, everything in them is performed with less apparatus. In the day time, the action of the beat on the leaves draws to them in abundance the nutricious juice. The small excretory vessels, that appear in the form of globules, pyramids, filaments, separate the more aqueous or gross parts of the juice that rises from the root. The air contained in the trachae of the stalk and branches, by dilating itself more and more, presses the ligneous fibres, and by that means accelerates the course of the sap, at the same time that it causes it to penetrate into the neighbouring parts. When night approaches, the inferior surface of the leaves begins to perform one of its principal functions. The little mouths it is provided with open themselves, and receive the vapours that float in the atmosphere. The air of the trachae is confined within them; their diameter, is lessened : the ligneous fibres being less pressed, enlarge themselves and admit the-juices conveyed to them from the leaves. These juices join themselves to the residue of that which bad arisen in the day time, and the whole mass tends towards the roots. This seems to be exactly the mechanism to which the motion of the sap may be reduced. You now see more clearly the design of the direction of the leaves, and of their admirable reverting. The inferior surface being intended for imbibing the dew, should face the earth, from whence this vapour rises gradually at sunset. But when I say that the principal office of this surface, at least in trees and shrubs, is to receive the dew, I would not infer that the opposite surface is incapable of it: that may perhaps absorb vapours that are more rare.

Experiments that are well made seem to prove that the inferior surface of the leaves of trees serve likewise for insensible perspiration. Those leaves in which this surface was endued with a matter impenetrable by water, drew in and transpired much less, in an equal time and with the same management, than leaves of the same size and likeness, whose inferior surface had not been endued with such a varnish. It seems to have resulted from the same experiments, that there is but little perspiration by the upper surface. We may thence infer that one of its principal functions is, to serve for a shelter or defence to the lower surface : and that no doubt is the use of the glossy varnish observable on the superior surface. All which agrees with the almost spontaneous motions and directions of the leaves, and with their symmetrical distribution round the stalks and branches.

5. The plant being enclosed in miniature within the fruit or seed, there encompassed with a quantity of flour, which after being diluted by the water that has penetrated the enclosures, ferments and furnishes the germ with its first nourishment. Being moistened by the delicate milk, in proportion to its weakness, it grows from day to day. In a short time its coverings become incommodious; it endeavours to divest itself of them, and pushes forth a little root, which proceeds to seek for more nourishing juices- in the earth. The little stalk appears in its turn, As it is destined to live in the air, it pierces the earth, and darts perpendicularly into the aerial fluid. Sometimes it carries along with it the remains of the teguments that had enwrapped it in the germ state: at other times it is accompanied by two leaves, which are very different from those of a mature age; these are the seminal leaves, whose principal use is probably to refine the sap.

Though it is divested of its swaddling-clothes, if we may so term them, the young plant is not at full liberty. It is not in a condition to be exposed so early to the impressions of the air and sun. All the parts remain for a short time folded together, nearly as they were in the seed. But the root, by extending and ramifying itself more and more, conveys to the vessels a considerable quantity of sap, which soon opens all the organs. At its first appearance the plant is almost gelatinous. It assumes by little and little a greater degree of consistence by the incorporation of the juices which

flow to it from all parts. That part of the stalk next the root increases in bulk, extends itself, and hardens first of all. As the hardening augments, the extension diminishes. At length it entirely ceases in this part, anti continues in that which immediately follows. Such is the nature of the progression observed in the whole plant.

Wood, whose hardness is sometimes equal to that of stone, is formed of a succession of concentric layers, that are detached every year from the inside of the rind, and harden as they advance in age.

6. Vegetables multiply by seed, shoots and slips. The pistil and stamina are to plants what the organs of generation are to animals. The former encloses the seed; the fine powder of the latter fecundates it. Both sexes are frequently united in the same subject: and those species are real hermaphrodites. Others bear the pistil on one branch, and the stamina on another. A third sort are like the greater part of animals, distinct males and females. The former are furnished with a pistil, and the latter with stamina. This is all we know with regard to the generation of plants. When the stamina are cut off, the seed remains unfruitful. The same thing happens when any one that has pistils has not in its neighbourhood another provided with stamina. The pistil is always so disposed as to be able to receive the dust of the stamina. Its top is perforated with holes proportioned to the diameter of the grains of this dust, and its inside is divided into several canals, whose diameter diminishes the nearer they approach to the bottom. At the base of the pistil the seed is deposited. Every grain of the dust of the sta. mina is a box, wherein floats, in a kind of very thin vapour, an infinite multitude of other very minute grains. This box opens itself to the moisture, and discharges a small mist of globules or grains. The shrinking of the trunks indicates that the containing globules do not reach to the bottom of the pistil: but the contained globules or grains are set at liberty by the action of the moisture which the trunk imbibes, which by opening the little box that encloses them, permits them by this means to penetrate to the ovary.

7. Vegetables multiply by shoots. They push forth from the circumference of their root several suckers, which become plants them selves, and propagate their species in like manner. The branches and young shoots may likewise be considered as ingrafted on the principal plant, making one body with it. The germs which are dispersed within the plant, enfold themselves there without any Sensible fecundation, and reach to the surface of the bark. They appear there in the form of a small oblong and rounded body, composed of: several parts, ranged in a very regular manner, and shaped like tubes, shells, &c. This little body is the bud, which like the seed, encloses the young plant under several coverings, all the parts of which are completed with abundance of art. The little stalk shoots forth a similar bud at its upper extremity. This bud opens, and produces a second stalk, grafted on the first, which it lengthens. This new stalk produces a third ; the third a fourth, and so on successively. When the tree has attained its full growth, it is composed of a series of small trees, placed end to end. it is the same with respect to branches and boughs, all having one and the same life, and forming only one organical whole.

Bulbous plants, instead of young shoots, send forth suckers. The bulb, which is formed of several membranes, or coats placed on each other, contains, in like manner, as the seed and bud, a plant in miniature. The sucker is a small bulb that shoots out on the sides of the principal one, and which is designed to succeed or replace it. Sometimes this replacing is performed with such quickness and circumstances as are very surprising. Whilst the principal bulb is wasting, the sucker thickens

and spreads itself, and in a short time becomes the principal bulb.

We may compare this bulb to a species of earth, that exhausts itself in order to furnish suitable juices to the young plant. It may also be looked upon as a placenta, that filters and prepares the nutricious juice. Tine leaves of some herbaceous plants form spherical masses that are pretty compact, and seem to perform the office of a bulb. The head of a cabbage spends and wastes itself in order to contribute to the unfolding of the minute stalk it contains. Place one of these heads on a vessel full of water, and it will exhibit to you the same phenomena as the bulb of a flower.

8. The branches that bend down from certain trees to the earth, take root there, and become themselves young trees. Human industry carries this kind of multiplication to a much greater extent. By means thereof, a single branch or root, divided into several parts, becomes SO many individual plants. What do I say It can even cause a tree to be produced from the smallest shred of aleaf. Such is the multiplication from slips. The organs essential to life being dispersed throughout the whole body of the subject, the slip that is detached from it, and planted in the earth, is of itself capable of forming new productions: it has every thing necessary for the unfolding of the radicals and buds. Thus a single leaf takes root, and vegetates by its own strength.

There is another kind of multiplication that is very remarkable, which consists in planting one or more slips, not in the earth, but in the trunk or branches of living trees. This is grafting; the first idea of which may perhaps have been owing to the accidental union o two branches or two fruits.*

*It has been observed by some authors that grafting has been practised from very remote antiquity. Theoprastus says that a bird having swallowed a fruit whole, cast it forth in a cleft, or cavity of a tree, where mixing with some of the putrified parts of the wood, and being washed with the rain, it budded and produced within the tree, a tree of a different kind; and that hence originated the art of grafting. The utility of grafting, is to propagate any curious sort of fruit, so as to be certain of the kind, and which cannot be effected by any other method. A cion of one kind, grafted on the stock of another, may be considered merely as taking root, in the body of the tree in which it is grafted: for it is evident that the cion preserves its own proper nature, and functions, though it be fed and nourished by a mere crab.

If all trees resembled one another in their structure and juices, the size and elasticity of their vessels, &c. probably the grafts of all trees would succeed upon one another. But this is not the case. It is indispensible therefore, that there be a certain degree of congeniality between the graft, and the stock, that their propensities and functions nearly correspond, that the graft may become as it were a natural branch of the stock. And this reciprocity should not only be attended to, as it respects the humours, but the seasons of fructification particularly, should be regarded, and this probably is the best criterion in this department of husbandry

There are various modes of grafting, and they are discriminated by the terms,. check-grafting cleft-grafting, crown-grafting, root-grafting, side-grafting, whip grafting, and in-arching. But whip-grafting, and cleft-grafting are principally used, and the former more frequently than the latter; check-grafting is performed by cutting off the head of the stock horizontally, then cutting one side sloping 1 or 2 inches deep. And cutting the lower part of the graft sloping the same length, with a shoulder to rest upon the top of the stock, which is to be inserted in a slit of the stock and bound round with catgut, or a strong cord. Cleft-grafting is The next cause of the union of the graft with its

subject, is in the intercourse of the sap-vessels with each other; and this intercourse depends ultimately on the relation of their parts, and particularly on that of their consistence, and the liquors contained in them. By the assistance of a graft the gardener causes the wild stock to produce the finest fruits, he gives youth to trees, and gathers plumbs from the almond tree, and pears from the ash. Filtrating, and the preparation of the juices of the subject by the vessels of the graft, occasion these productions. The roll, which is always formed at the insertion, and is composed by the interweaving of a prodigious number of fibres, is one of the principal instruments of these preparations. The more or less perfect analogy of the juices proper to the subject with those that are peculiar to the graft, favours in a greater or less degree the unfolding of the latter. The nearer or more distant relation between the time in which the sap in the subject continues, and that in which the graft has been accustomed so to do, contributes likewise more or less to the success of the operation. performed upon stocks from about one to two inches in diameter. First with a strong knife, or small saw, the head of the stock is cut off, and one side cut sloping downwards about 1 inches. Then the cion is prepared to be inserted in a cleft of the stock which is effected with a strong knife or chisel. The cion is prepared by cutting it to an edge, in the shape of a knife, and which is inserted edge. ways into the cleft of the stock. If the stock is large enough, several cions may be inserted in this manner. Crown-grafting is commonly practised upon such stocks as are too large to cleave, and is often performed upon the large branches of apple, or pear trees, which already bear fruit, when it is intended to change the sorts, or renew the tree with fresh bearing wood. This should be performed in March or early in April. Thi, kind of grafting is performed, by inserting the graft about two inches between the bark and wood of the stock.—Root-grafting is performed by whip-grafting cions upon pieces of the root of any tree, of the same genus, and planting the root where it is to remain. It will take root, draw nourishment, and feed the graft.—Side-grafting is performed by inserting grafts into the sides of the stock, without heading them down; and may be practised upon trees to fill up any vacancy, or for the purpose of variety, or to have several kinds of fruit upon the same tree. It is performed by sloping of the bark and a little of the wood, and cutting the lower end of the graft to fit the incision as nearly as possible, then tying them round with catgut or strong cord, and claying them over.—Whip-grafting is always performed upon small stocks, from the size of a goose quill, to about an inch in diameter, more or less: in this kind of graft. ing it is best that the cion and the stock be nearly of a size, it is performed by preparing the cion with a tongue, about two inches, projected from a shoulder. which is to- rest evenly on the surface of the stock.—In-arching is only performed when the trees intended to be grafted, grow near each other. And it is done by inserting the branches of the one into the bark of the other, whereby they form an arch, whence the name. This being a sure method, it is commonly practised upon such trees, as are with difficulty made to succeed by any of the other methods. An anonymous author, in a treatise published at Hamburgh, entitled amaeni tates Hortenses Novie, highly recommends a new method of grafting trees, which for beauty, flavour, and quantity of the fruit, exceeds all others, producing beautiful pyramids of fruit. This he says he had long experienced. It is performed thus.—The trees are to be transplanted in autumn, and all their branches cut off. Early in the following Summer, the young shoots are to be pruned off, and the buds are to be ingrafted into them in an inverted direction. This he says adds not only to the beauty of the pyramids, but makes the branches more fruitful. These are to be closely connected with the trunk, and to be fastened in with the common ligature: they are to be placed circularly round the tree, three buds in each circle, and these circles at six inches distance from each other.

The old trees may be grafted in this manner, the success having been found very good in those of twenty years standing; but the most eligible trees are those which are young, vigorous, and full of juice, and are not above a finger or two thick, when these young trees are transplanted, they must be fenced round with pales to defend them from the violence of the wind; and there must be no dung put to

9.The body of the plant is in a continual state of motion. It always tends to produce, either the bark, a bud, or a root. Make an incision in a tree; the wound will cicatrize. A greenish roll will in a short time be seen at the top of the wound, afterward on the sides, and at length towards the bottom. This roll is a new rind, which is about to cover the wood again, without uniting to it. Observe what passes with respect to this; you wilt perceive in it certain distinct and glutinous nipples, and small, reddish spots dispersed here and there, which you will find to be a growing bark. A matter that is partly transparent, whitish and mucilaginous will seem to raise up this bark. All these glutinous substances will thicken, increase in length, and become stronger, and in a little time, what was at first of a gluey nature, will be herbaceous, cortical, and ligneous. The cicatrice will at length entirely close itself, and restore the communication between all the vessels. The wood does not only differ from the bark by its density, but it has likewise organs that are not to be met with in the latter. it seems to be peculiarly possessed of air-vessels. When a new rind seems to convert itself into wood, this conversion is only in appearance. Nature does not create more air-vessels than are suited to one entire plant. But a multitude of fibres that are destined to become wood, pre-exist under the new rind, and unfold themselves with it and by it, as we see the butterfly unfold itself in and by the caterpillar. Whilst wood is nothing more than a mucilaginous drop, it is not on that account the less wood, than when being transformed into a pillar, it is made to support the enormous weight of an edifice. them till they are thoroughly rooted, for fear of rotting them before the fibres strike. The buds ingrafted must be small that the wounds made in the bark to receive them, not being very large, may heal the sooner; and if the buds do not succeed, which will be perceived in a fortnight, there must be others put in their place. The wound made to receive these buds must be parallel to the horizon; and the piece of bark taken out, must be downwards, that the rain may not get into the wound. in the autumn of the same year, this will be a green and flourishing pyramid, and the next summer, it ‘will flower, and ripen its fruit in autumn. In the union of the graft with its subject, we likewise perceive a glutinous substance to spring from each of them, which spreads, ramifies, and is formed into a ball in both, becoming by degrees herbaceous, cortical. ligneous, and composes above the insertion a roll which entirely covers it. So that the whole body of the plant is furnished with small fibres on the inside, which only wait for favourable circumstances to display themselves. These circumstances are a wound, an incision, or a simple ligature. These fibres are the elements of cortical or ligneous beds, which, by spreading themselves on all sides, furnish the necessary repairs. The wound, incision and ligature, occasioning the nutricious juices to flow towards these invisible fibres, expand them, and render them perceptible to us.

What these fibres perform in the regeneration of the bark or wood, the germs effect in the reproduction of a branch or. young shoot. The fibres of the bark or wood do not unite themselves into hunches, in order to compose a bud or branch in miniature. This branch is already completely formed in its germ: it there possesses the elements of all the beds, whether cortical or ligneous, which it will hereafter exhibit under different proportions.

Chapter 07 - Of Animal Economy

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1. The nerves, which extend themselves into all parts from the brain, are distinguished into several principal divisions, that are more or less numerous, or more or less extended. Each division reaches to the part for which it is destined, and whose structure corresponds with the functions appointed for it to exercise.

Feeling, sight, hearing, taste and smell, are five kinds of senses, which contain under them an almost infinite number of-species. The shaking which the mediate or immediate impression ok objects produces on the nerves, give birth to those different kinds of sensations, which may all be reduced to feeling, of which they are properly only modifications. The organs of the senses are the instruments of these modifications. The number, extent and delicacy of the senses. constitute the degree of animal perfection. The nerves, which seem to resemble the strings of a musical instrument, are not stretched like them. Some animals are endowed with an exquisite sensation, that are themselves little otherwise than a thick jelly: how then can we admit of elastic strings in this jelly While the foetus is altogether gelatinous, it regulates at that time its members. With what amazing swiftness then must the impressions of objects communicate themselves to the soul! and with what wonderful celerity must the members obey the will! Thus we are led to suppose in the nerves a very subtle and elastic fluid, whose motions, being analogous to those of light, or electrical fluid, produce all the phenomena of sight. The animal spirits are this fluid, which the brain extracts and prepares, and continually conveys into the nerves, and by the nerves into all parts, which it nourishes, moves and animates.

2. An animal had in vain received senses, by means of which it can distinguish between what is useful or hurtful, if it were not able to give itself any motion for the attaining the one, and avoiding the other. It is therefore furnished with organs that procure to it this faculty, These organs are the muscles, which by the dilitation and contraction, and by the lengthening and shortening of the fibres that compose them, communicate to all parts the motions which are suited to the wants of the animal.

It is evident, from experiments, that the nerves contribute to the exercise of the muscles. The spirits which they disperse therein, insinuate themselves into all the vesicles, dilate them, and by that means put the organ into action.

One property of the muscular fibre, whose effects are diversified a thousand ways, the cause of which is concealed from us, is that, by virtue whereof it contracts itself on the touch of any body, either solid or liquid. This is called irritability. By means of this, different parts of the animal continue to move, after they have been separated from the entire body; and the heart, when detached from the breast, performs a number of pulsations, which cease as soon as the blood in the cavity is evacuated.

3. From that part which gives admittance to the food, to that from whence issues the remains of the grosser aliment, there is one continual canal, which is formed differently in different parts of its extent. There are three principal parts distinguished in it: the oesophegas, the stomach, and the intestines. All these are formed of various membranes laid on each other, and which are themselves composed of fibres differently interwoven. The muscles, wherewith one or several of these membranes are furnished, impress divers motions on the organ, the principal of which, called the peristaltic motion, bruises the aliment, and forces it from place to place. The oesphagus receives the grosser nourishment, and transmits it to the stomach, that prepares it : it afterward passes into the intestines, where it undergoes new preparation. From thence it enters into some very small vessels, that convey it to those of circulation, where it assumes the name of blood.

Whilst the most delicate part of the aliment is subject to all these preparations, the grosser part is evacuated by different ways. Some times the animal discharges it as a sediment sometimes, being trans formed into a subtle liquour, it is carried to the surface of the skin by an infinite number of very fine vessels, whose exterior apertures are sometimes so small that a grain of sand is capable of covering several thousands of them.

Other vessels, which, like them, communicate with the surface of the skin, pump in the vapours that float in the air, and convey them into the blood.

4. Circulation is that perpetual motion by which the blood is conveyed from a point internally to the extremities, and flows back again from the extremities to the same point. The point from whence the blood springs, is called the heart. It has two motions, one of con. traction, or systole, by means of which it forces out the blood contained in its cavity; the other of dilation, or diastole, by which it receives the blood again.

Two kinds of vessels join to the heart: the arteries, which convey the blood to the extremities; and the veins, which carry it back from the extremities to the heart. The arteries have, like the heart, their systole and diastole, and divide and subdivide themselves, as do the veins, into an infinite number of branches, which diminish in diameter in proportion to their distance from their origin. The perpetual motion of circulation prevents the corruption and extravasation of the nutricious fluid, rectifies it more and more, and disposes it insensibly to renew the nature of the animal.

5. Respiration comprehends two alternate motions; one of inspiration, which gives admittance to the air within ; the other, of expiration, which expels it, filled with the vapours of the animal. The lungs are the principal instruments of respiration.- They are principally formed of a collection of cartilaginous and elastic vessels. which, after being divided and subdivided into a prodigious number of branches, meet in different parts, and terminate at one or more common trunks, called trachae, or air vessels, whose aperture is on the outside of the body. The ramifications of the air vessels are connected with the vessels of circulation, and accompany them in their passage through the lungs.

6. The blood is that rich fund from whence nature derives that diversity of materials she employs with so much art in the construction of her wonderful edifice. This, as it goes from the heart, meets here and there on its passage, with certain organical, and as it were knotted masses. in which it is deprived of part of its principles.

We cannot yet penetrate the true mechanism of secretions: we can only faintly perceive,, that they may operate by a gradual diminution of the vessels which proportions them to the smallness of the particles that are to be separated. They may likewise bear some affinity to the configuration of these particles, and favour the extraction of them by means of the slackening which their folds and various circumvolutions occasion to the circulation. Thus it is, that by causing the aliment to pass through an infinite number of strainers, nature is enabled to assimilate it to the animal, and incorporate it into his flesh. This is then neither chyle nor blood ; it is a much more refined liquor, and known by the vague name of lymph.

We cannot sufficiently admire the prodigious apparatus of vessels which perform the secretions of different kinds. The kidneys, the liver, the pancreas, &c. are labyrinths in which the most consummate anatomist is bewildered. We can only discover an inconceivable mass of white tubes, of an extreme minuteness, folded together in thousands of different ways, which do not admit of any injection, though adhering to the blood vessels, and being placed end to end by imagination, would have formed a chain of several leagues in length. This is all that art has discovered in the secretory organs. But what a number of interesting particles do these minute, hollow cylinders contain, which have escaped our notice and instruments! What varieties should we not discover in their structure, functions and exercise, were we permitted to descend to the bottom of this abyss, which conceals from us one of the greatest mysteries of nature! All the animal liquors are more or less mixed, and these small tubes no doubt sufficiently diversify themselves to separate the various molecules that must necessarily enter into- the composition of every liquor. What then must be the structure and fineness of those that filter this so subtle fluid, compared to ether or light, whose operations are diversified almost to infinity,

7. If we knew how a single fibre grows, we could tell how the animal grows; for his whole body is only an assemblage of fibres. differently formed and combined. Growth always operates by nutrition. This incorporates into the fibre molecules of an heterogeneous nature, which extend in every part. The fibre incorporates into itself the heterogeneous molecules according to its own nature. A. fibre is itself composed of other fibres: these of still other fibres of which there would be no end. But the fibre is formed of molecules or elements, whose nature, proportions, and arrangement, respectively determine the species of the fibre, and adapt it to such or such a function. Thus the elements of the fibre ultimately effect assimilation, which by uniting with the nutricious molecules, that have an affinity with them, give them at the same time an arrangement like that which they have in the fibre. The extension of the fibres sup. poses that its elements may separate more or less from each other: but this separation hath its bound, and these bounds are those of the growth. In proportion as the fibre grows, it acquires more solidity. for the number of incorporated molecules increases every day, since it only grows by the successive incorporation of molecules of a fo reign nature. The more the solidity augments, the more the supple ness diminishes. There are more molecules, more coherence, and more attraction under the same foldage. The fibre then tends to a state of hardness, and the last term of its hardening is the last term of its growth. When therefore the fibre has acquired its full growth, it is a little organized whole, composed of its elementary molecules, and of all such as nutrition has incorporated with them during the time of their growth. If then we could separate from the fibre all those molecules which it has assimilated, we should restore itto its primitive state. This may be applied to all organized bodies. They are, if we choose to term them so, net-work. A secret force impels the

ailment into the meshes. It increases them in bulk, and supplies them by little and little. It likewise insinuates itself into the elements of the solid mass itself. The net-work stretches, thickens, and at length becomes hard.

8. We may easily comprehend, that all the parts of an animal have such strict and indissoluble connexions between them, that they must necessarily .have always co-existed together. The arteries imply veins; both of these imply nerves; the latter the brain ; this the heart; and all of them suppose a multitude of other organs. in the germ of a chick there is at first perceived a vital point, whose constant motion attracts the attention of the observer. The alternate and quick contractions and dilatation of the living point, sufficiently indicate that it is the heart. But this heart seems to be without any covering, and to be placed on the outside of the body. instead of appearing in the form of a minute pyramidical mass, it bears the resemblance of a semicircle. The other viscera appear successively, and range themselves after each other, round the living speck. We cannot as yet discover any general folding; all is transparent or nearly so; and we only perceive by little and little those teguments which are appointed to cover all the parts. In its first beginnings the animal is almost entirely fluid. It assumes by degrees the consistence of a jelly. All the parts have at that time situations, forms, and proportions that differ greatly from those they will afterward acquire. Their minuteness, softness, and transparency, serve to strengthen the illusion. We persuade ourselves that a bowel is naked, because the transparency of its coverings prevent our seeing them. Would you have a short and easy demonstration of this When the lungs of the chick are first perceivable, their size is but the thousandth part of an inch. It would have been visible at the fourth part of these dimensions, were it not endued with the most perfect transparency. The liver is much greater at its first appearance ; its transparency alone renders it invisible. It is the same with respect to the kidneys whilst they do not appear even to exist, they separate the urine. The heart forces the blood into the arteries sooner than we could imagine, and it can only be perceived by the growth of the embryo, which is never more accelerated than at the very beginning.

Many other facts concur with these to establish the pre-existence of organical wholes. We are now sensible that many insects multiply, like plants, by slips. We cut them into pieces, and each piece regenerates, and becomes a perfect animal. Earth worms are ranked in the number of those insects that are reproduced from their disjoined parts; and being very large, the phenomena of their regeneration is very perceptible. The piece that is cut off never acquires any growth; it always remains as the section left it; only it falls away in a greater or lesser degree. But aftersome time there appears a very small whitish pimple at its extremity, which increases by degrees in bulk and length. There are soon discovered rings, which are at first very small and very close. They spread themselves insensibly every way. New lungs, a new heart, a new stomach, disclose themselves, and with them a number of other organs. This piece, which is newly produced, is extremely slender, and altogether disproportioned to the part on which it grew. We may imagine that we see a worm growing, that it is grafted at the end of this stump, endeavouring to lengthen it. This little vermiform appendage unfolds itself slowly. At length it equals in thickness the piece from which it was cut, and exceeds it in length. It can no longer be distinguished from it but by its colour. which is somewhat fainter.

Here then is a new organical whole, which grows from an ancient one, and constitutes the same body: there is an animal slip that grows and expands itself on the stump of an animal, as a vegetable slip does on the trunk of a tree. Remark that the flesh of the piece cut off does not in the

least contribute to the formation of the part regenerated; the stump only nourishes the bud; it being the soil in which the latter vegetates. The part then that is reproduced passes through all the degrees of growth, by which the entire animal itself had before passed. It is a real animal, which pre-existed in a very minute form in the great animal that served it for a matrix.

Vegetable productions exhibit to us the same consequences. If a tree be topped, that does not lengthen the trunk of it; but it sends forth a multitude of buds, in each of which a little tree is comprised for the bud or branch that springs from it is a tree that is grafted on the trunk that nourishes it.

Every seed, in like manner, comprises a plant in miniature. On a very slight inspection, we may very easily discover the stalk, leaves, and root of this little plant. But the curious rise much higher, and distinguish in a bulbous root or growing bud those flowers that do not blow till the ensuing year. When the evolution commences in an organized whole, its form differs so prodigiously from that which it will afterward assume, that should be apt to mistake it, were it not to accompany it in all its Progress. Observe how the parts of a plant are folded together, entwined. or concentred in the seed or bud; Is this that majestic tree which will ere long overshadow a large space of ground This the flowers that will so gracefully display itself This the fruit that will assume such a regular figure You can now only perceive an uniform ed mass of knotted filaments; yet this little chaos may already contain in it a world, where all is organized and symmetrical.

You have seen frogs in their first state. They appear at that time to consist only of a large head and a long tail. Such is the chick when it begins to expand itself. A very slender tail, stretched in a straight line, is joined to a large head; and the tail contains all the rudiments of the composition; nay, is the very composition itself; and the transparent fluid in which it floats, constitutes the whole of those soft parts with which it is afterward covered. The same revolutions, therefore, which occasion the heart of the chick to be transformed from its semicircular shape to that of a pyramid, bring the chick itself to a state of perfection. If we were permitted to penetrate to the foundation of the mechanism whereby these successive changes are effected, what a degree of certainty would our knowledge of animal economy acquire We should contemplate in an egg, the mysteries of the two kingdoms. And how greatly would our imagination of that adorable wisdom be increased, which by the simplest means ever attains the most noble ends

9 Thus the more we ascend to the origin of organized beings, the more we are persuaded of their having pre-existed before their first appearance; not such as they first appear to us, but disguised; and were it possible for us to trace them still higher, we should undoubtedly find them stilt more disguised, and should be at a loss to conceive how they could afterward acquire that form under which they present themselves to our view.

We can then form no idea of the primitive state of organized beings; that state which I conceive to be given them by the hand of Him who has ordained all things from the beginning. The forms of vegetables and animals, which are so elegantly varied, are, in the system of this admirable pre-ordination, only the last results of that multitude of successive revolutions, they have been liable to, and which perhaps commenced at their first creation. How great would be our astonishment. could we penetrate into these depths, and pry into the abyss! We should there discover a world very different from ours, whose strange decorations would infinitely embarrass us. The state, in which we conceive all organized bodies to have been at first, is the germ state;

and the germ contains in miniature all the parts of the future animal or vegetable. It does not then acquire organs which it had not before: but those organs which did not hitherto appears begin now to be visible. We do not know the utmost limits 0f the division of matter; but we see that it has been divided in a prodigious degree. From the elephant to the mite, from the globe of the sun to a globule of light, what an inconceivable multitude of intermediate degrees are there! This animalcule enjoys the light; it penetrates into its eye ; it there traces the image of objects; how extremely minute must this image be! And bow much more minute must that of a globule of light be, when several thousands, and perhaps millions, enter attbe same time into this eye! But great and small are nothing in themselves, and have no reality but in our imagination, it is possible, that all the germs of the same kind were originally joined or linked into each other, and that they are only unfolded from generation to generation, according to that progression which geometry endeavours to assign them.

10. A barren egg has a yolk as well as a fruitful egg. And a ray of light has lately sprung, which has greatly brightened the shades in which the mystery of generation is yet involved.

Bestow your whole attention on this; you will then discover an important truth. A membrane clothes the inside of the yolk of an egg: and this membrane, which is only a continuation of that which clothes the slender intestine of the chick, is common to the stomach, pharynx, mouth, skin, and epidermis. Another membrane enfolds the yolk externally, and this membrane is only a continuation of that which covers the intestine; it unites with the mesentery and peritoneum. The arteries and veins that gently move in the egg, derive their origin from the mesenteric arteries and veins of the embryo. The blood which circulates in the yolk receives the principle of its motion from the heart. The yolk then is essentially a dependance of the intestines of the embryo, and together with that composes one and the same organized whole. So that at its primary period, it is in some measure an animal with two bodies: the head, trunk, and extremities, compose one of these bodies; the intestines and yolk the other. At the end of the incubation, the second body connects with the first, and both together form only one. But since the yolk exists in eggs that have not been fecundated, it necessarily follows that the germ existed before fecundation. This consequence is self-evident: you have lately seen that the yolk is an essential part of the chick: you have observed the strict communication between them. The chick then has never existed without it. The membranes and vessels of the former, are only a continuation of the membranes and vessels of the latter. And what a number of other things are there which are common to both, and which prove that they have never existed separately! The chick was then entire in the egg before fecundation. It does not therefore owe its origin to the liquor furnished by the male, but was sketched in miniature in the egg, previous to it. Consequently the germ belongs solely to the female. Such is the grand conclusion which immediately flows from facts.

1.The yolk has its liquors, which are conveyed to it by the arteries belonging to it. They circulate, and without veins there is no circulation. But the arteries and veins of the yolk take their origin from the mesenteric arteries and veins of the foetus; the heart of this latter therefore is the principle of that circulation which is performed in the yolk. At the time of fecundation the foetus does not weigh the hundredth part of a grain. The yolk at that time weighs a dram. It has vessels proportioned to its size. Now if the germ existed entire before fecundation that which we style generation is not the same thing with it; but is only the beginning of an evolution, which will by degrees bring to open day such parts as were before hid in impenetrable darkness. But the germ cannot be unfolded in

an egg which has not been fecundated, and incubation would only accelerate its eruption: What does it then want to enable it to continue to grow It has all the organs necessary for evolution. It has even already attained to a certain degree of growth, for eggs grow in young pullets ; their ovaries contain them of all sizes. The germ grows there likewise. Why cannot it enfold itself more than it does What secret force retains it within the limits of invisibility

Growth depends on the impulsion of the heart. A greater degree of growth depends on a greater impulsion. T his degree of impulsion, consequently, is wanting in the heart of the germ that has not been fecundated. This demonstrates a certain resistance in the parts of the germ. As it grows, this resistance augments in proportion. Some resist more than others ; the bony parts, or such as will hereafter become so, more than the membranous, or those that always must remain so. The heart of the germ then hath need of a determinate strength to surmount this resistance. Its strength is in its irritability, or in the power it has of contracting itself on the touch of some liquid. Wherefore to augment the irritability of the heart, is to augment its impulsive force.

Fecundation, without doubt, increases this force, and that can alone increase it; since it is only by the intervention. of it that the germ passes over the narrow limits that it retained jfl its first state.

12. The fecundating liquor then is a true stimulus, which being conveyed to the heart of the germ, excites it in a powerful manner, and communicates to it a new activity. Herein consists what we call conception. Motion being once impressed on the little moving body, is there preserved solely by the energy of its admirable mechanism. But it is not sufficient that the heart should acquire a force sufficient to surmount the resistance of solids ; it is likewise necessary that the fluid which it conveys to them, and which should nourish them, be proportionable to the exceeding fineness of the vessels. Such a blood as ours would not circulate in them. The blood of the embryo is at first a whitish liquor it grows yellow by degrees, and afterward red. The more the impulsion of the heart dilates the vessels, the more gross, heterogeneous, and colouring particles they admit. The prolific liquor then is not a mere stimulus ; but is likewise a nutricious fluid appropriated to the extreme delicacy of the germ. It has already discharged the functions of a nutricious fluid in the fecundating individual; has caused its comb, spurs, &c. to grow, anti give strength to all its parts. Being conveyed by the arteries to all its parts, it unites itself to the nature of each. From thence proceeds growth, which we do not pay a sufficient attention to.

It is not long before the chick loses the first form. Wings, thighs, legs, and feet, spring out from its long tail. Every thing is formed and disposed on a new model. The little animal, which before was stretched out in a straight line, becomes more and more curved. It is successively clothed with muscles, tendons, flesh, and feathers, and in eighteen or twenty days is a perfect chick.

13. if the chick pre-existed in the hen, it is probable the horse pre-existed in the mare. This would be more than probable, if it could be demonstrated that the young of viviparous animals are enclosed in eggs: and that all the difference between viviparous and oviparous may be reduced to this, that the former are batched in the belly of their mother, and the latter after their issuing from it. On the two sides of viviparous females there is a body resembling a small bunch of grapes, whose berries are bladder full of a limpid liquor. These are the ovaries. They communicate with the matrix by two canals which they call tubes. The prolific liquor penetrates in the matrix, and passes through the tubes into the ovaries. Thus fecundation is performed. Foetuses have more than once been found in the ovaries itself. Nay more, there has been found in the vesicle of the ovary a

complete foetus sketched in miniature. The vesicles of the ovary are real eggs, which after fecundation descend through the tubes into the matrix, and are there in some measure brooded on. In a short time they send forth small roots' which convey the nourishment to the embryo. The suppleness of their membranes admits of their extending, and making way for the growth of the little animal. It is true, the growing of eggs is familiar to us; but the history of insects furnishes us with many examples of it. It even exhibits to us insects that are at one time viviparous, and another oviparous. The young were in that case at first lodged in eggs; sometimes the mother lays her eggs; and at another brings forth living young ones, which were hatched from these eggs whilst they were yet in the matrix.

It is therefore the same with respect to the vesicles of the ovary, as the eggs of the hen; a germ pre-exists in them, but its transparency conceals it from us; fecundation renders it visible.

14.But if an ass cover a mare, there will be produced from this commerce an animal that will not properly be a horse, but a mule. Nevertheless a horse was delineated in miniature in the egg of a mare: how then was it transformed into a mule Whence did it acquire these long ears and slender tail so different from those of the horse Dissection increases the difficulty ; that informs us that this kind of transformation does not only effect the exterior part of the animal, but the interior likewise. The voice of the mule is very like that of the ass, and does not at all resemble the neighing of a horse. The organ of the ass's voice is an instrument that is very much compounded. A drum of a singular structure, lodged within the larynx, is the principal part of this instrument. This drum does not exist in the horse, hut is found in the mule. The liquor furnished by the male consequently penetrates the germ, since it there produces such great changes. But these relations of the prolific liquor to the male that furnishes it, must necessarily depend on the organs that prepare it.

There are then in these organs vessels that separate the molecules relative to different parts of the great whole. These molecules are carried to the corresponding parts of the germ, since these parts are modified by the action of the prolific liquor. Therefore it incorporates itself with the germ, and is the first aliment of it, as I said above. The organs of generation in the ass have then a relation to his ears and larynx ; for they prepare a liquor which modifies the ears and larynx of the little horse enclosed in the egg. The prolific liquor creates nothing, but it may change what already exists. It does not engender the chick, which existed before fecundation.

Growth depends on nutrition; the latter on incorporation. At the dame time that a part grows, it acquires solidity. An excess of growth in a part, then, supposes a superabundance of nutricious juices or such as are more active. The excessive growth which the ears of the horse acquire by the influence of the liquor of the ass, indicates that this liquor contains more molecules, appropriated to the unfolding of the ears, than that of the horse, or that the molecules of the first are more active than those of the second. The extreme softness, I should rather say, fluidity of the germ, renders every part of it extremely modifiable. Those changes which you cannot conceive in an adult, depend here on the slightest causes. But if the fecundating liquor modifies the germ, this latter in its turn, modifies the action of that liquor. By virtue of its organization, it tends to preserve its primitive stale, resist more or less every new arrangement, and never gives way without always retaining something of its primitive form.

15. Every organical production, which has more or less parts than the species requires, or constructed otherwise, is a monster. The male, which doth not engender, is therefore a monster.

The object of inquiry in a celebrated dispute, was, whether certain monsters were such originally or by accident

It is evident, that the mule is not a monster from its origin. Monsters do not exhibit so much constancy and uniformity. Does an egg, of which the mule is formed, offer itself in the ovary of the mare just at the instant in which the ass fecundates it

Two branches, fruits, or leaves, graft themselves accidentally, and afterward compose but one and the same whole. Art performs other more extraordinary engraftings, in all of which there is nothing originally monstrous. That which happens between two fruits that engraft themselves, or are engrafted by force, may happen in the matrix between two eggs, or in an egg between two germs. Two foetuses that are united only by the spine, perfectly resemble two fruits that are grafted by contact. An egg sometimes contains two yolks, consequently it then contains two germs. How easy a matter is it for them to engraft themselves together as they unfold We have seen a chicken with four feet, which undoubtedly proceeded from a like union. The germs, which are first fluid, and for a considerable time gelatinous, are very penetrable. If they come in contact, they will mix together in part. Similar organs, which at least half penetrate each other, will subsist in the other moiety. We see clearly this reciprocal penetration in a human foetus having two heads on a single body. This monster was evidently formed of two moieties of the foetus connected together.

If their gelatinous state renders germs very penetrable, it favours with much greater reason their union by grafting, or that of some parts to each other, either of the same germ or two or more germs. The graft is united to its subject only by gelatinous or at least herbaceous fibres. Such fibres are proper for forming new productions, and for connecting and intermingling together. Two polypus unite together much more easily than two rinds; they are abundantly softer.

16.Accidental grafts may give birth to monsters which we should term inexplicable, by this principle. But you have not forgot, that all organical parts have forms and situations in the germ which differ prodigiously from those they will have in the unfolded fcetus. Recal to mind the chick in its first form, its heart in that of a semicircle and you will comprehend that those conjunctions, which appear impossible to you, in the foetus may be easily effected in the germ. The analogy of parts likewise favours their union. This analogy results from that of the elements. Two membranes are more disposed to unite than a membrane and a bone; and similar parts of the;! same organ, than parts of different organs.

Lastly, evolution is not uniform in all parts of the germ : they grow unequally, and this inequality of growth may influence the effects of contact, pressure, adhesion, &c. Thus a monster that is produced with superfluous members, may derive them from a germ that has perished, and of which only these members remained. We plainly see bow many causes may destroy such or such a part, and produce a monster by defect. But all monsters by excess might not owe their origin to the union of two germs. Certain parts may grow excessively by the concurrence of particular circumstances, and augment the number of similar parts in the same individual. A subject with twenty-six ribs is really a monster by excess, It has been proved that supernumerary ribs are entirely owing to the unnatural developement of a bony appendage of the transverse apophysis of one of the vertebrae. The causes which operate in the like unfoldings, act nearly as the liquor of the ass on the ears and larynx of the horse. As supernumerary ribs unfold themselves, so two or three ribs unite themselves into a single one, and these kind of cases are not rare either in the

vegetable or animal kingdom. Such parts as almost touch each other, are very apt to unite: two drops of jelly, and of the same jelly, unite very easily.

17. The principles I have laid down concerning the generation of animals, are likewise applicable to that of plants. What the prolific liquor is to the former, the dust of the stamina is to the latter. There is a wonderful analogy betwixt these two classes of organized bodies. The seed, which so nearly resembles the egg, does therefore, in all probability contain a germ, which existed in an invisible manner before fecundation, which makes it sensible to us. It appears first of all like a greenish or yellowish speck. It has been thought that a grain of the stamina dust has been perceived in this speck. The germs have en this account been placed in this dust, and introduced themselves into the seeds, which were destined to receive and nourish them. But can we discover the germ in the egg before fecundation Notwithstanding which it pre-exists there. it is highly probable that it likewise pre-exists in the seed, and that its minuteness, together with the transparency of its parts, conceals it from our sight.. Will a philosopher argue, that because a thing is invisible to us, it does not therefore exist

18. An exact observer has taken a good method to clear up the mystery of the generation of plants. He considered what has resulted from the fecundation of diverse species, by the dust of different species. Be has seen mules that have been well described proceed from it. These mules, when combined with other species, have produced new ones. The resemblances have always been in a direct proportion to the dust. The changes and alterations have always been sensible. The female has had some superiority. The privilege of fecundity has adhered more exactly to what came from her, than to that which proceed from the male. Do not these curious observations themselves indicate that in vegetables, as well as in animals, the germ originally belongs to the female

Chapter 08 - Of Animal Economy, Considered in Insects

Chapter 8 - Of Animal Economy, Considered in Insects

I. The sketch I have lately drawn of animal economy, affords a slight idea of what constitutes the essence of life in most animals.. We shall now treat of the principal varieties which the organizations of different species presents us with. Insects, hitherto little known,. exhibit some singularities in this very, respect, to which we shall. confine ourselves by way of preference, in order to avoid such details as might carry us to too great a length.

We have already seen, in some measure, the different parts contained in the composition of these little machines: we will now contemplate their exercise and various effects.

2. The mechanism of respiration is very obscure in insects. We only know that in them it differs greatly from that in those animals which are most known to us. But we judge with greater certainty concerning this difference by the comparison of the organs, than by that of their exercise. When a drop of greasy liquor is applied to one or several stigmata of an insect, the corresponding parts become paralytic. The interception of the air in one part is followed by that of liquors or spirits. When we stop up all the stigmata, the insect dies immediately. If we afterward open them, we shall perceive the inside to revive. The air, which then penetrates the open orifices of the tracheas, evidently produces this kind of resurrection. The tracheae or air vessels, are divided and sub-divided in a prodigious degree. May they not resemble so many sieves, which by separations suitably contrived, are capable of furnishing to each part an air of a more or less subtle nature, as occasion requires There are commonly reckoned to be nine stigmata on each side of the body: but sometimes there are more in number, at others fewer. The same insect has some that are of greater or less importance to it, or whose functions are more or less necessary. In several species, the principal stigmata are placed behind: in others at the head. Instead of stigmata, they are pretty frequently observed to have little tubes of different lengths.

3. The circulation of the blood is performed in insects with great regularity. We trace it by our sight, in some species of long and transparent worms. We may see the heart, or principal artery, con. tract and dilate itself successively in every part of its extent. It seems to be composed of a great number of little hearts, placed end to end, that transmit the blood to each other.

We are yet ignorant in what manner the blood is conveyed into the grand artery Its principal ramifications, and the canals analogous to veins, are equally unknown. We are only certain, that in many species, for the most part of the creeping sort, the principal of circulation is towards the hinder part, whereas, in others, it is towards the head. It is very probable that the grand artery shoots forth, from both sides of it, several branches that are invisible, by reason of their extreme fineness or transparency, and that distributes the blood to every part. Other branches are without doubt connected with them, and conduct the residue of the blood to the principal trunk of veins, which is imagined to be perceived on the opposite side of the heart. The blood of insects is a subtle liquor, transparent, commonly without colour, and though it be not in the least inflammable,

resists in some species, a degree of cold, superior to that of our severest winters.

4. The organs of generation, in most insects, are placed at the extremity of the belly. That which characterizes the male, consists principally of one or two species of fleshy horns, which are turned different ways, and are generally drawn within the body, but emitted from thence at the pleasure of the insect. The hind part of divers males is also furnished with hooks, by means of which they fasten or that of the females. In the interior part are lodged different vessels, which are connected with the principal organ of generation, and separate the fecundating liquor from the mass of blood. At the end 0f the aperture formed in the female, there is joined a kind of canal, which in many insects, sends forth several branches, called tubes or ovaries. These are species of very fine intestines, in which the eggs are ranged in a row, almost like the beads of a chaplet. The eggs nearest the aperture are the largest, or in a more advanced state. They gradually diminish according to their distance. At length they become altogether invisible. In the common passage, where the ovaries terminate, there is inserted, in some species, a very short canal, which communicates with an oblong cavity, that is considered as analogous to the matrix. In this cavity the liquor of the male is deposited.

Amongst viviparous animals the economy of the tubes changes. Sometimes the young are ranged in bunches. At others they form a kind of cord twisted spirally, whose length, width, and thickness exactly correspond in number to the length and thickness of the young that compose it. The young of some viviparous insects, before they are brought forth, tear the membrane or ovary that encloses them; they are, to use the expression, on this account subject to a two-fold birth. The eggs of insects are of two kinds: some are membraneous, like those of tortoises and reptiles : others are crustaceous, as are those of birds. But whereas in large animals the species comprised under these genera differ only from each other by a slender variety; amongst insects these varieties are so great, that one animal does not differ more from another, than one of their eggs does from another. Some of them are round, elliptical, lenticular, cylindrical, pyramidical, flat. Some are quite smooth, others grooved or channelled. In short, what is more extraordinary, there are some eggs that grow after they are laid. We easily judge that they are entirely membraanus. The suppleness of their membranes admits of their extension. They have pores that imbibe the juices of the plant where they are deposited. These are minute placentice that transmit the nourishment to the embryo.

5. The distinction of insects into viviparous and oviparous does not only take place in species of different classes, but likewise in species of the same germs. There are some two winged flies that are viviparous, and others that are oviparous.

Add to this, that some species are viviparous, at one time and oviparous at another. The vine-fretter furnishes an example of this.

All great animals that are known to us, are distinguished into males and females, and propagate the species by copulation. The same order prevails amongst insects; but all the species are not subject to it, and, of those that are, several afford some very remarkable singularities. In divers species the male is winged, and the female not. The glow-worm which is sentenced to crawl during its whole life time, is fecundated by an insect having four wings.

Sometimes this striking singularity is joined with others that are still more surprising. Every where else we observe a certain proportion betwixt the male and female ; here this proportion vanishes entirely. The female is a colossus, on which the male walks as on spacious spot. The ardour and agility of the male are excessive. He is almost in continual motion. The female, on the contrary, moves but seldom, and that heavily. She sometimes spends the greatest part of her life in the most perfect inactivity. In fine, the male is an insect properly so called, his whole body is intersected by incisions that are very conspicuous: The female is a spherical mass, fixed to a branch, that one would be apt to take for an excrescence or gall nut of this branch. You will imagine that I am speaking of gall insects, whose name so welt explains their deceitful appearances. They are found in great numbers on the branches of many trees and shrubs. They are greatly diversified; but always affect the form of gall nuts more or less round. They imbibe the juice of the tree by the assistance of a little pump, which they keep fixed to the bark. They lay some thousands of eggs, which are piled up under the mother's belly, as they-issue from it. When the whole number is laid, the gall insect dies, and its carcase remains-fastened to the branch. This is only a cod full of eggs, which one might still take for a living gall insect, so small an appearance of life is there in this strange animal. The young are hatched in a short time, when there immediately appears a multitude of very small animated membranes, either oval or circular, which are borne on six legs, and disperse themselves on all sides with a wonderful celerity.

6. Several of the species that live in society, present us with three sorts of individuals; to wit, males,- females and neuters, or individuals that remain always deprived of sex. This we observe in the republics of bees, 'wasps, and ants. We know that each swarm of bees has but one female, which bears the name of queen; the males, which are called drones, pretty often amount to four or live hundred; the neuters, which are much more numerous, are sometimes forty or fifty thousand in number. These are the ilotes of the little Sparta; they are charged with all the labour. The queen and drone are wholly taken up in furnishing the state with citizens. She is, in a literal sense, the mother of all her people ; she lays in one year upwards of fifty thousand eggs. She produces three sorts of them, from. whence are hatched three kinds of individuals of different shape. The neuters then construct three sorts of cells, to receive 'the eggs, and lodge the young to be hatched from them.

Divers species of insects are real hermaphrodites; in each individual both sexes are united, but he cannot fecundate himself; and generation depends in this case, as elsewhere, on the concurrence of two individuals.

7. Other insects are hermaphrodites of a more singular nature; each individual propagates without any commerce with another. We have the first example of this in the vine-fretter, that deserves some attention.

You have very frequently seen little flies fastened in a great number to the extremities and leaves of plants, and twisting them round in various forms: these are vine-fretters, whose species are almost as numerous as those of vegetables, and whose remarkable properties are multiplied in proportion to the attention we pay them.

They bring forth living young ones. Their births are easy to trace; there needs only good eyes and a little patience. Take up a little one as soon as it is produced: enclose it immediately in the most perfect solitude, and in order to be the better assured, carry your precautions to a degree of

scrupulousness; be with respect to it a more vigilant Argus than the fabulous one. When the little recluse has acquired a certain growth, it will begin to have young, and after some days you will find it in the midst of a numerous family.

Make the same experiment on one of the individuals of this flimily that you have tried on its chief: the new hermit will multiply like its father, and this second generation brought up in solitude, will not prove less fruitful than the first.

Repeat the experiment from one generation to another; abate nothing of your cares, your precautions, and suspicions; proceed, if your patience will permit you, to the ninth generation, and they will all present you with fecund virgins.

After these experiments, so decisive and reiterated, you are easily persuaded that there is no distinction of sex in vine-fretters. What indeed would be the use of such a difference amongst a people where all the individuals are constantly sufficient for themselves Natural history is the best logic, because it best teaches us to suspend our judgment. Vine-fretters are really distinguished by sexes; there are males and females amongst them, and their amours are least equivocal of any in the world. I do not know whether there are in nature any males more amorous than they.

What then is the use of coupling between insects that multiply with-out its assistance Of what service can an actual distinction of sex be to real androgynes The clearing tip of this point depends on another great singularity. During the summer season they are viviparous;' they' all bring forth living young. Towards the middle of autumn they become ovipurous they all then lay real eggs. which are hatched at the return of the spring. The males begin to appear exactly at the time the females begin to lay. There is therefore a secret relative betwixt the appearance of the males, and the laying of the females, There are always found in the bodies of the females, eggs and ready to be produced. The young then were originally enclosed in eggs. During the fine season, they are hatched in the belly of their mother, and are brought into the world alive. Plants at that time furnish them with a proper nourishment, which they fail not instantly to embibe by the help of a very slender trunk. At the approach of cold weather, the young cannot unfold themselves in the dam's belly, in order to their being produced alive; they remain shut up their eggs, where they are preserved the whole winter. Were they to be hatched at the beginning of that season, they would soon perish for want of food. The developement depends ultimately on nutrition. Vine-fretters that are produced alive, are more unfolded in the matrix than those which are brought forth enclosed in eggs. The former. then have received a nourishment in the matrix, which the others were. not able to obtain there. This nourishment was sufficient to effectuate. the entire opening of the germs. Had not coupling, then, for its primary end, the supplying the defect of this nourishment in such germs as were not to be hatched till after they had issued from the belly of their mother.

I have treated of some species of insects, the males of which are winged, and the females not. This singularity is also to be met with among vine-fretters; but they offer still more to us with respect to this. Some of the males are winged, and others remain their whole life time without wings. There are likewise winged females, and other females that are not. But this is not all: the males, and particularly those that are destitute of wings are so small in comparison of the females, that they are seen to walk upon them as a mite upon fruit; to so great a degree has nature thought fit to abound, with regard to these insects, in singularities of different kinds.

8. Animals that multiply by slips and shoots, and that may be grafted appear to be real zoophytes, or plant animals. Of these some have feet or members, others not. We shall first treat of the latter sort. The slime which covers the bottom of ponds and marshes may almost be deemed a respectable thing: there the Great Being has not disdained to assemble the traces of his power and wisdom. He has connected the existence of this vile matter with that of different species of worms, that are destined to live in and feed upon it, and that will one time or other present us with the interesting sight of a new reproduction, which we shall never think we can sufficiently admire, and shall therefore wonder at it in proportion as our understanding is enlightened.

All these worms are long and slender. They are not unlike the treble string of a violin; their body is formed of the succession of a great number of little rings, which decrease gradually as they approach the extremities. They are very soft: their head, which terminates in a blunt point, is susceptible of various motions. It contracts, dilates, lengthens, and shortens itself at the pleasure of the insect. The mouth is furnished with a muscle that directs the functions of it, and whoseexercise is pretty perceivable. The anus, which is placed at the opposite extremity, is a little oblong aperture, bordered with an analogous muscle. The whole skin is so transparent, as to admit of its being inspected within, and we may congratulate ourselves on this circumstance, since it affords us a great spectacle. The polypus exhibits nothing that has the appearance of the viscera. All its substance seems to be composed of a mass of small similar seeds. Our fiddle-strings are minute beings, quite differently organized, and the apparatus of the viscera, which the microscope discovers to us, seems to advance them far above the polypus. A long vessel that goes winding from the head, to the tail, is what chiefly strikes the eye of the observer, by its regular alternate motions, he will soon know it to be the heart or grand artery. The liquor that circulates in these winding passages is limpid. It is perceived from the pulsations it excites in every part of the artery comprised betwixt two of the rings One would be :tpt to imagine each of these portions to be a real heart, and that every artery was a chain of little hearts, placed end to end, and that forced the blood from one part to another. It is seen to run with an uniform motion through all these little hearts, and rises in this manner; as by so many bladders from the tail to the head, near which it finally disappears. In different parts of the artery are discovered delicate ramifications of vessels, which may be taken for veins, there being perceived no pulsation in them. Beneath and along the artery there is a canal, whose diameter varies at different points of its extent. It is the intestinal duct, which comprehends the oesophagus, stomach, and intestines. The alimentis there seen to digest before the eyes of the observer: he follows it in its passage : sees it descend from the mouth towards the anus, and pass through every part of the canal between these two extremities. But can machines so compounded as these be taken to pieces without injuring their economy thereby That suffers not in any respect on that account. Strictly speaking, it affects these insects no more than being divided in the midst of the body. Each half not only continues to live and move: but that which bad no head presently forms another, and we may clearly perceive a new tail spring forth in that part which was destitute of one. In less than three days the two moieties become two complete worms.

It is more extraordinary for fourths, eighths, and sixteenth parts of our worms to assume a head and tail: this is so speedily effected, that in a few days all these fragments are so many insects, and after a few weeks attain to the same length as the entire worm. New rings and new viscera unfold themselves, the parts reproduced differ in no respect from the ancient ones. Thus the

machine is formed anew its own strength; and the section, which might be a means of destroying them, serve only to make them conspicuous.

I have not yet sufficiently treated of this particular. The six and twentieth part of worms, to wit, perfect atoms, are able to re-integrate themselves extremely well, and in the space of some months are found to be worms of several inches in length. In these living atoms, as well as in the most considerable fragments, the circulation seems to be per formed with the same regularity as in the whole worm. Each atom has its little heart, and we may clearly perceive that this little heart is no other than a very small portion of the grand artery of the worm;' whereof the atom was before a part.

We may weary ourselves in cutting the head off the same individual we shall have the same task to repeat continually, because there always; shoots forth a new one. We may even cause several to issue at the same time, each of which shall have their proper functions.

There is another species of these worms, amongst which the property of becoming again entire is confined in very remarkable bounds. It forms a head or tail in the middle; but if it be cut into three or four parts, the intermediate ones push forth a tail where a head should have been produced. This supernumerary tail, which is in no respect deficient, cannot perform the office of a head, and the unhappy insect is condemned to perish with hunger.

9. Look into this rivulet, whose bottom is covered with broken pieces of plants: what do you perceive upon them Spots of mouldiness. Do not mistake: this mouldiness is not what it appears to be;' and you already begin to suspect so ; you think that you greatly ennoble them by advancing them to the rank of vegetables; you conjecture they are plants in miniature, that have their flowers and seeds, and plume yourself on being able to judge of these mouldinesses in a different manner from the vulgar. Take a magnifying glass: what do you discover Some very pretty nosegay, all the flowers of which are in bells. Each bell is supported by a small stalk, which is implanted in a common one; you now no longer doubt of the truth of your conjecture, and cannot be persuaded to quit this microscopic parterre. You have not however sufficiently observed it. Look steadfastly on the aperture of one of these bells: you will there perceive a very rapid motion, which you cannot be weary of contemplating, and which you compare to that of a mill. This motion excites little currents in the water, that convey towards the bell a multitude of corpuscles. which it swallows up. You begin to doubt whether these bells are real flowers and the motions of the stalks which appear to be spontaneous, increase your suspicions Continue your observations nature herself will teach you what you ought to think 0f this singular production, and will furnish you with fresh motives for admiring the fecundity of her ways. That is a bell which detaches itself from the clustre, and that floats along in order to fix itself to some support. Follow it. A short pedicle issues from its extremity: and the bell fastens itself by the end of this pedicle. It lengthens and becomes a little stalk. It is no longer a nosegay you are beholding, it is a single flower. Redouble your attention ; you are just arrived at the most interesting moment of inspection. The flower is closed, has lost its form of a bell, and assumed that of a bud. You perhaps suspect that this bud is some fruit, or a seed that has succeeded to the flower: for you are both to give up your first conjecture. Do not lose sight of this bud; it is now divided by degrees according to its length, and the stalk is at present supplied with two buds, less than the first. Examine what passes in both of them. They widen themselves insensibly, and you perceive a motion at the edge of the opening, which increases in swiftness in

proportion as the bud unfolds itself The mill appears again, and the two buds have assumed the form of a bell. Can a fruit which changes into flowers, be a real fruit Can such flowers be real flowers, that swallow little insects Suspend your observations, and repeat them a few hours hence. Your flowers are closed up as the first was ; you easily guess that they will separate themselves as before, afterward open, and present you with four bells. That is already effected, and you have a little nosegay, composed of four flowers. If you continue your inspection, you will see them augment in bulk by new divisions in two's, and soon after you will count sixteen, thirty-two, sixty-four flowers. Such is the origin of this microscopical parterre, which at first drew your attention: how much more admirable does it now appear than you then 'conceived it to be! What a group of wonders does a single spot of mouldiness afford! What unforeseen, varied, and interesting scenes, are transacted on a scrap of rotten wood! What a theatre does it exhibit to a thinking being! But our abode is so recluse, that we have but a glimmering view of it; how great would our ravishment be, if the whole spectacle disclosing itself at once to us, we should be enabled to penetrate into the interior structure of this wonderful assemblage of living atoms! Our blunted eyes discover only the most striking parts of them; they only apprehend the gross parts of the decorations, whilst the machines that execute them remain concealed in impenetrable darkness! Who shall enlighten this profound obscurity Who shall dive into this abyss where reason itself is lost Who draw from thence the treasures of wisdom and knowledge concealed within it Let us learn to be content with the small portion communicated to us, and contemplate with gratitude those first traces of human understanding imparted to us, towards a world placed at such a great distance from us

10. You cannot quit this spring, from whence you have derived many truths that are so astonishing. You discover in it other microscopical animals, whose form resembles that of a funnel. These are likewise polypuses. They do not compose a clustre ; but cleave some body by their inferior extremity ; you are Curious to know their method of multiplying. In order to this, place your microscope one of these funnels. Of a single funnel, there are formed two by a natural division ; but very different from that of bell-polypuses; so far has nature thought fit to vary her proceedings with respect to these animals. Examine what passes in the middle of the funnel. A verse and oblique stripe indicates to you the part where the polypus is about to divide itself. The division then is made slopingly. The stripe points out the edges of the new funnel, and these are only the lips of the fresh polypus. You discover in them a pretty slow motions, which helps you to discern them. They approach each other insensibly, the body collects itself by degrees; a little swelling forms itself. on the side, which is a new head. You already clearly distinguish two polypuses placed above each other. The upper polypus has the former head and a new tail ; the inferior one a new head and the former tail. The upper polypus is connected with the other only by: its lower extremity. By a motion it gives itself, it is at last detached from the other: and floats away in order to fix elsewhere. The inferior poly pus remains fastened to the place where the funnel was before the division.

11. Net-polypuses likewise derive their name from the exterior. form of their bodies ; they pretty nearly resemble that of a fishing-net. They assemble in groups, and fasten on all the bodies they meet with. in fresh water. They are very transparent. In the inside of the polypus there is formed an oblong and whitish body. As soon as it is formed, it descends by degrees, shows itself on the outside, and remains fixed perpendicularly on the polypus It produces new ones every day; and

the group they compose on the exterior part of the polypus, increases in growth. If these minute bodies be eggs, they are of a singular species; they are absolutely without any covering, and are neither membraneous nor crustaceous. We cannot affirm of these eggs, that young are hatched from them, but are under a necessity of acknowledging, that these little oviform bodies unfold themselves. This developement is accomplished in a few minutes, and the polypus becomes the same as its mother: imagine to yourself a bird that should issue from its mother's belly, entirely naked, rolled together like a ball, whose members should afterward display themselves, and you will have a representation of the production of net-polypuses.

12. Cluster-polypuses propagate by dividing in the middle; arm-polypuses do not multiply in this manner. They bring forth their young almost as a tree shoots forth its branches. A little bud appears on the side of the polypus. Do not suppose that this bud contains a polypus, as the vegetable bud comprises a branch: it is itself the polypus in its growth. It increases in size and length, and at last separates from its mother. Whilst it is united to her, they both compose one body, as the branch with the tree. You are to understand this in the strictest sense. The prey, which the mother swallows, passes immediately into her young, and imparts the same colour to it. So that the whole consists of one little bowel of a great extent. The prey which the young one seizes, (for it fishes for it as soon as it has arms) passes in like manner into the mother. They nourish each other reciprocally.

There is scarcely any polypus without buds. All of them there. fore are so many polypuses, or so many shoots that grow on a common trunk. Whilst they are unfolding, they themselves send forth smaller shoots, and these smaller still. They all extend their arms on both sides. You think you are beholding a very bushy tree. The nourishment received by one of these shoots, is soon communicated to all the rest, and to their common mother; the chief of the society and the members are one. The society is dissolved by little and little, the members separate themselves, are dispersed, and each shoot becomes in its turn, a little genealogical tree.

Such is the natural method by which the arm polypus multiplies. It may also be multiplied by slips. There is no need to mention, that when it is cut in pieces, each piece in a short time becomes a perfect polypus. It were better to say at once, that the polypus, after being cut into small pieces, rises again from its ruins, and the little fragments yield as many polypuses. Being cut either in length or width, this extraordinary animal is reproduced in the same manner, and the sources of life are equally inexhaustible.

13. But the following is what fable itself has not presumed to invent: bring to their trunk the heads that have been struck off, they will reunite to it, and you will restore to the polypus its head. You may also, if you think proper, affix to it the head of another polypus. The mutilated parts of the same or different polypuses, when placed end to end, will unite in like manner, and form only a single polypus.,

What have I hitherto said There is scarce any miracle that may not be performed by means of the polypus; but miracles, when multiplied to so great a degree, hardly appear to be such. A polypus may be introduced by its hind part into the body of another polypus. The two individuals unite, their beads become ingrafted into each other: and the polypus, which at first was double, is converted into a single polypus, that eats, grows and multiplies.

I have compared the polypus to the finger of a glove: this finger may be turned inside out: so may the polypus likewise, and being so shifted, can fish, swallow, and multiply by slips and shoots.

It will be easily believed that the polypus does not like to remain thus shifted. It makes an effort to regain its former position, and frequently succeeds either in part, or altogether. The polypus, which is partly turned back again as at first, is a real Proteus, that assumes all kinds of forms, which are all equally strange. Endea your to represent to yourself the polypus thus turned again. You remember that the insect is made in the form of a bowel. One part of the bowel then is turned backwards on the other; it there fastens and engrafts itself. In that case, the polypus is as it were doubled. The mouth encompasses the body like a fringed girdle; the arms are the fringe. They then point towards the tail. The fore part continues open; the other is usually shut up. You expect, no doubt, to see a new head and new arms, to grow out of the fore part; which you have observed in all the polypuses that have been divided transversely. But the polypus combines itself a thousand different ways, and each combination has its consequences, which experience alone can discover to you. The fore part closes itself; it it becoming a supernumerary tail. The polypus, which was at first extended in the right line, is curved more and more. The supernumerary tail lengthens every day. The two tails resemble the feet of a pair of compasses. The compasses are partly open. The ancient mouth is at the head of the compasses. This mouth, which is fastened to the body, and embraces it like a ring, cannot discharge its functions. What then must become oc the unfortunate polypus with two tails and without a head How will it be able to live Do you think that you have taken nature at unawares You are mistaken. Towards the upper part of the polypus, near the ancient lip, there are forming not only a single mouth, but several; and this polypus, concerning which you inquired a minute ago how it could exist, is now a species of hydra, with several heads and mouths, and devours with all these mouths.

14. What a multitude of physiological truths, that were unknown to us in the vegetable kingdom, has the arm.polypus alone unveiled to us How do these truths appear as paradoxes, and yet how evidently are they demonstrated Who can doubt now that there exists an animal,* a very animal, since it is extremely voracious, whose young grows like branches, and which being cut to pieces and actually minced, regenerates anew in all its parts, and even in the smallest fragments, that may be grafted by aproximation or inoculation, turned inside outwards like a glove, afterward cut, turned back and cut again, without ceasing, to live, devour, grow, and multiply

* Naturalists have been uniformly straightened in the attempt, to institute a positive criterion for the line of demarkation between animal and vegetable beings: and equally so for that between vegetables and fossils. There is such an obvious gradation in the scale of beings, that it appears impossible to ascertain where one species ends, and the other begins. At first thought it would appear imposing, that the criterion of sensibility, and reflection was adequate to the object. But students in natural philosophy, have found themselves so bewildered by the infinite gradation of these characters, that they have been necessitated to resort to other modes of discrimination. In one instance it has been supposed as sufficiently discriminative, of fossils, vegetables, and animals, that fossils grow and increase; that vegetables grow and live, and that animals alone have sensation. Boerhaave attempted the discrimination by fructification, and a mouth And considered the vegetable world as properly distinguished by its blossoms and fruit, and the animal, by the mouth. But here it has been objected, that as blossoms and fruit are mere appendages of growth, and maturity, and a mouth merely the instrument by which nourishment is conveyed to the

body; they cannot be considered as an essential distinction; because fossils are also subject to the different stages of growth, maturity, and decay. And vegetables also require nourishment, and are furnished with instruments (or conveying it into their bodies; and where the end is the same, a difference in the means can never be essential. The fixing the difference in a gula, stomach, and intestines, as is done by Dr. Tyson, is as little to the purpose. Some naturalists have assumed locomotive powers, as an absolute criterion for discriminating between animals and vegetables; but lord Kames has confronted this position by several curious instances of the locomotive powers of plants, some of which he says would do honour to an animal. Indeed the instances of apparent sagacity and economy in vegetables are very numerous, and the almost total want of it in some animals is equally striking. The petals of virgin flowers are observed to expand in the sun, but contract at night, or on the approach of rain; but after the seeds are fecundated, they cease to contract. Some plants turn to the sun, others turn from it: many plants in the night vary the positions of their leaves, and this is styled the deep of plants. A hop plant twisted round a stock, directs its course from S. to W. as the sun does; untwist it, and tie it in the opposite direction, it dies. Leave it loose in the opposite direction; it recovers its natural direction in a single night. The root of a tree meeting with a ditch, is laid open to the air: it alters its course like a rational being; dips into the ground: surrounds the ditch: rises on the opposite side, to its wonted distance from the surface, and then proceeds in its wonted direction. By comparing the above and other instances of seeming voluntary motion in plants, with that share of life, wherewith some of the inferior kinds of animals are endued, and putting sensation out of the question, we should scarcely hesitate at ascribing superiority to the former. The sensitive plant, the hop, and the honeysuckle, would claim precedence to many species of beings, which we rank as animals. Some muscles for instance are fixed to one place as much as plants are, nor have they any power of motion except that of merely opening and shutting their shells: and in this respect, they have no superiority over the sensitive plant. Nor doth their motion discover more sagacity, nor even so much as the roots of the plane tree mentioned by lord Kames, which directed its roots ten feet down a wall, to come at a greater supply of nourishment. But there are instances wherein nature appears to combine the animal and vegetable functions, in the same beings, and thc polypus may be considered as the intermediate lint between the two kingdoms.

It was not a fit season, therefore, to make general rules, to arrange nature, establish distributions, form systematical orders, and to raise an edifice, which future ages, better instructed, will even dread to project. We have scarce any knowledge of the animal when we would undertake to define it. Because our knowledge is at present is some measure improved, shall we presume to think we thoroughly know it. Polypuses have astonished us, because on their first appearance there was no idea in our brain analogous to them, and we had taken great pains to discard from it the very possibility of their existence. How many animals are there that are even more strange than polypuses, and that would confound all our reasoning, could we discover them! It would be necessary on that occasion to invent a new language, in order to describe our observations. Polypuses are placed on the frontiers of another universe, that will one time or other have its Columbuses and Vesputiuses. Shall we imagine that we have penetrated into the interior parts of the continents, because we have taken a slight view of some coasts at a distance We will form to ourselves more exalted ideas of nature ; we will consider her as one immense whole, and will firmly persuade ourselves that what we discover of her, is but the smallest part of what she contains. Having been heretofore astonished, we will forbear being so for the time to come, but will

continue our observations; we will amass fresh truths, connect them if we are able, and be in expectation of every discovery, because we will continually say, that the known cannot serve as a model for the unknown, and that models have been varied ad infinitum. Cluster-polypuses multiply by dividing themselves; who can tell but that there may one time or other be discovered animals, that instead of dividing themselves, may unite together, and join themselves to one another, in order to compose one single animal Or who knows whether the multiplication of such an animal may not have as an essential condition, the consolidation of several animalcules in a single one We say that an animal must have a brain, a heart, arteries, veins. nerves, a stomach, &c. These are the ideas we have deduced from large animals, and we carry them every where with confidence. We act herein like a French traveller, who should expect to find in the Terra Australes the mode of his own country, and that would be greatly chagrined on being disappointed. The animal kingdom has also its Terra Australes in which probably it is not customary to meet with a brain, a heart, a stomach &c. Why do we desire that nature should always condescend to form one animal with the elements of another She might indeed be constrained so to do, did not her fecundity surpass that of our poor conceptions! But the Hand, which has formed the polypus. has demonstrated to us, that it can, when necessity requires animalize matter at a much less expense. It has descended by almost insensible degrees from those great organized masses we call quadrapeds, to those minute organized bodies we style insects; and by gradual and skilfully contrived subtractions, it has at length reduced animality to her smallest terms. We are unacquainted with these smallest terms. The polypus, simple as it appears to be, is without doubt, very much compounded, in comparison of such animals as are placed beneath it in the scale. It is, if we may be allowed the expression, too' much an animal to be the last term of animality. We know that the brain is the principle of the nerves, that it filters the spirits; that the nerves are the organ of feeling; that the heart is the primum mobile of circulation ; that the veins and arteries are the dependencies; all this we have seen in great animals, we have again to our surprise found it in insects: though under different forms; we were thus accustomed to regard these various organs, and some others, as essential to the animal. The polypus, however exhibits to us nothing similar; the best microscopes only discover to us an infinite number of small disseminated seeds in its whole substance; and the unforeseen experiment of its shifting, sufficiently proves that there is nothing in its structure common to that of animals-before known to us. Were we not capable of imagining, that an animal had been endued with the property of being propagated and grafted like a plant, it would have been much less possible for us to suspect that there had been granted to it the power of being turned inside out like a glove. The arm-polypus, is nevertheless a perfect animal; its voracity is excessive; it devours all the little insects that happen to touch it, and seizes them with such skill, as seems to give it an affinity to hunting animals. The cluster-polypus, quite differently constructed, has not the same advantages, but has relative ones ; it can excite a rapid motion in the water, which bring towards it those living corpuscles it feeds upon. There are undoubtedly many animals that are still much more disguised than the cluster polypus, and by not affording us any exterior sign of animality, leave us for a long time uncertain of their true nature. When a bulb of such a polypus is detached from it, and fixes it by its short pedicle to any support, should we be apt to consider it as an animal production has not the gall insect been taken for a real vegetable gall-nut by such observers as had not seen it in its primitive' state Is not the pond muscle deficient in many things we judge to be necessary for the animal How many shell fish are still farther degraded Nay more, there may probably exist some animals which it would be

impossible for us to acknowledge as such, even though their whole structure, as well internal as external, should be laid open to us; the reason is, that judging only according to our present notions, we cannot deduce from this structure the opinion of life.

15. I cannot yet quit this subject. We are notable to conceive the methods by which the author of nature has given life and sensation to a prodigious number of different beings. Let us judge of at least by a comparison of a small number of animated beings we are acquainted with. How greatly does life differ in the ape and bell. poly pus What intermediate degrees are there betwixt those terms Perhaps there are still more from this polypus to the last us animals. I do not examine if souls have been varied like bodies; but I conceive that organized matter has been modified infinite to which have corresponded as many different methods of Participating life and sensation. I likewise conceive that the same soul, if placed successively in all the organized bodies that exist, would Successively experience all the possible modifications of life and sensibility. This soul would pass through all the degrees of animality; and if she could remember them all, and compare them, she would equal the superior intelligences in knowledge. She would contemplate our world through all those glasses that have been given to the various beings that inhabit it.

16. Let us draw a general consequence from all this: that analogy which is one of the great lights of physic, is not capable of dissipating the shades of it. This light is frequently extinguished on the approach of certain bodies which we bring to the touch of experiment. To what purpose does analogy serve in the examination of the bulb-polypus We cannot even define these bulbs; and does the name we give them express any thing more than mere appearances How can analogy enlighten us concerning the nature of these minute bodies, and the manner by which they are engendered and engender, whilst she offers nothing to us either in the vegetable or animal kingdom, which bears the least relation to these productions, so different from all those that were known to us I affirm as much with regard to the natural division of the bells, and of the shifting of the arm-polypuses. This is an entire new order of things, which has its particular laws, which we should in all probability be able to discover, could we find some means of penetrating into the secret mechanism of these little beings. We should then discern all the sides by which they are connected with other parts of the organical world.

17. When we consider in a general view the composition of men and quadrupeds, we shall presently discern that there is with respect to all of them the same foundation of structure, differently modified in different species. In order to be convinced of this, we need only cast our eyes on those anatomical plates, in which are represented the skeletons of divers animals that have been dissected. From man, the ape, and horse, to the squirrel, weasel, and mouse, we shall see throughout the same design the same arrangement the same essential relations, except in a few particulars. The spine which is formed of a series of parts, joined to each other as by so many hinges, bears to its upper extremity a sort of bony box, of greater or less extent. Some bony arches, which on one side are connected with the spine, and on the other withpart opposite to it, form another more spacious box. The upper and lower extremities are joined likewise to the spine by different interposed bands, and maintain the body in those various attitudes its exigencies require. This economy is so generally observed, that it has even been remarked that the vertebrae of the neck are seven in number in all the species. Almost the same order is to be met with in birds and fishes:

It varies more and more in reptiles, shell-fish, and insects. The latter however have their bones, several parts of which seem to imitate the corresponding ones in great animals; but whereas among the latter the flesh covers the bones; on the contrary, among insects the bone covers the flesh. In this numerous class of little animals, nature has in an especial manner diversified her models the most, and displayed the wonderful fecundity of her inventions. In the large parts of the animal kingdom, she pretty nearly pursues the same plan of architecture, and hardly diversifies any thing but the orders. In one we behold the strength and majesty of the Tuscan; in others the elegance and delicacy of the Corinthian. But when she descends to insects, she seems entirely to change her plan, and to retain as little as possible of her first models. She seems at length to abandon them altogether in her formation of an arm or bell-polypus, She constructs plants on still different models: but these models retain in them something of the organization of animals, and particularly that of insects. The organs of respiration are almost the same in the plant and insect. Those parts which are essential to life, are dispersed throughout the whole body of the plant, as they are in insects that are reproduced by slips. Those plants which appear to be most elevated in the scale, exhibit to us a stalk, branches, roots, leaves, flowers, and fruit. A swine-bread, an agaric, a liverwort, on the contrary, are so extremely disguised, and have in them so small a resemblance to plants3 that it is necessary to have the eye of a strict observer, in order to know and characterize them. These half vegetable productions, if I may be allowed the phrase, seem in the vegetable kingdom, to be what the gall-insect, poly pus, and the muscles, are in the animal. They do not appear to be more organized than an amianthus, a talc, or a crystal.

18. The distance however is much greater from the most regular fossil, or that most resembling a vegetable, to the plant in the least degree so, or that is the least organized. The fossil does not grow, properly speaking: it does not receive nourishment, nor engender. It is formed of the successive apposition of different molecules, which by uniting together under certain relations, determine its figure. The plant is a body truly organized, which of itself works the molecules, destined to incorporate themselves with its substance, and to extend it every way; and contains little bodies resembling it, which it nourishes causes to expand themselves, and by means of which it multiplies its being. Nature then seems to make a great chasm in passing from the vegetable to the fossil, &c. There are no bands, no links hitherto known to us, which unite the vegetable to the mineral kingdom. But shall we form our judgment of the chain of beings by our present degrees of knowledge Because we here and there discover in it some ruptions, some void spaces, shall we conclude from thence that they are real Shall we imagine that a comet has split the scale of world, and destroyed the harmony of it We are only beginning to survey the vast cabinets of nature ; and amongst that innumerable multitude of various productions which she has assembled, how many are there which we have not so much as seen, and can frame no idea of their existence Shall we hasten to decide concerning the result of these productions, before we have examined them all, or formed exact list of them The vacancy we suppose left between the vegetable and mineral, will in all probability be one day supplied. There was a similar void betwixt the animal and vegetable: the polypus now fills it up, and sets in a conspicuous light the admirable gradation there is among all beings. It is true we cannot form any mean idea betwixt.. the plant and the fossil; we do not imagine there is any shadowing between growth and apposition: but had we formed any conception of the properties of the polypus If those marine productions, which have been called stony plants, were real plants, they were in some measure one of the links requisite for uniting the vegetable to the mineral kingdom. But late discoveries have informed us, that these

pretended plants are only works of certain polypuses, that have the art of constructing cases for themselves. Those coral flowers, so muck celebrated, were real polypuses; and this is another truth wherewith the polypus has enriched the physical world.

19. Organized bodies are tissues which are more or less fine pieces if net work, or pieces of stuff, whose warp itself forms the woof, by an art which we should think we could never enough admire, were we acquainted with it. Fossils are a kind of inlaid work. We do not know where the organization ends, nor which is its smallest term. But by ceasing to organize, nature does not cease to dispose or arrange. She even seems to organize when she has made an end of doing so. One would be ready to imagine that fibrous and leaved stones were vegetables in part disguised. The constant regularity of salts and crystals strikes us in an equal degree. We may be assured, that the crystal is formed of the repetition of an infinite number of small, regular and pyramidial bodies, properly laid on each other, which represent, in some measure, the whole exactly in miniature. We should notwithstanding, be very much mistaken, were we to consider these little pyramids as the germ of the crystal; it is strictly speaking no more than an element or constituent particle of it. It does not unfold itself, it remains as it was; but it serves as a support to other similar pyramids which are to be joined to it, and thus to augment the crystaline mass by successive aggregates. The crystaline juice is not received wrought, and assimilated by strainers or vessels that are more or less fine, or more or less folded together, within the pyramid ; it is already entirely prepared when it procures the union of different molecules into one pyramidal mass, by virtue of the laws of motion and attraction. This is the primary character which distinguishes brute from organized bodies: a character which we ought never to lose sight of, when we compare together beings of these two classes.

20. Thus the bodies of plants and animals are species of looms, machines more or less compounded, which convert into the proper substance of the plant or animal, the various matters subjected to the action of their springs and liquors. These machines, which are; so superior in structure to those of art, seem still more so when compared in their essential effects. Those matters which organical machines work, they likewise assimulate and incorporate with themselves; they grow by this incorporation, augment in their dimensions every way, and during their growth, all their parts preserve among themselves the same relations, the same proportions, the same exercise; all continue to discharge their proper functions: the machine remains in its extended state, what it was in miniature. It is a system, a wonderful assemblage of an almost infinite number of tubes, differently formed, calibered, and interwoven, that like so many filters, purge, fashion, and refine the nutricious matters. Each fibre; what am I saying! Each fibrilla is itself a machine in miniature, which by performing analogous preparations, appropriates to itself the alimentary juices. and gives them the arrangement suitable to its form and their functions. The whole machine is in some measure only the repetition of all these lesser machines, whose united strength conspires to the same general end. The excellence of organical machines appears in a conspicuous light from other still more striking instances. They not only produce, from their own foundation, machines similar to them, but a great number of them reproduce of themselves, those parts they had been deprived of, which various parts become afterward as many machines, equally perfect with those whereof they before only made a part.

21. To conclude: the same general design comprises all parts of the terrestrial creation. A globule of light, a molecule of earth, a grain of salt, a particle of mouldiness, a polypus, a shell fish, a bird,

and a quadruped, man, are only different strokes of this design : and represent all possible modifications of the matter of our globe. My expression falls greatly beneath reality; these various productions are not different strokes of the same design they are only so many various points of a single stroke, that by its infinitely varied circumvolutions, traces out to the astonished eyes of the cherubim, the forms, proportions, and concatenation of all earthly beings. This single stroke delineates all worlds, the cherub himself is a point of it: and that adorable Hand which drew this stroke, alone posseses the method of describing it.

Chapter 09 - Continuation of Animal Economy Considered in Insects

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1.In the seventh chapter you have seen the earth worm regenerate; you have contemplated the progress of this regeneration; you have remarked a little bud that grew at the fore part of the stump, which unfolding itself by degrees, became a vermiform appendage, a kind of little worm, that seemed to be ingrafted on the stump. This animal bud has discovered to you the first origin of the part that is reproduced. You have perceived that it was lodged in miniature under the fleshy parts of the stump, and that the latter does not contribute more towards this production than the earth does to the plants that have taken root in it.

Thus the earth worm contains, like the polypusses, a multitude of germs, which begin to unfold themselves as soon as certain accidents convey towards then the nutricious juices. The sources of reparation are here in proportion to the accidents that may threaten the animal. But the reproduction of the earth worm is much more astonishing than that of the polypus. It is not only an enormous Colossus in comparison of the polypus, but its structure is also much more compounded. It affords a more numerous apparatus of viscera, vessels, tracheze, muscles, &c. It has real blood, and this blood circulates. But it is besides an hermaphrodite: it unites at once all the organs peculiar to the two sexes. This insect, which in appearance is the most contemptible, would alone be sufficient to exhaust the sagacity of the ablest observer, though applying himself solely to the contemplation of it. What a gainer would physiology be from such an inquiry! What a number of truths, concerning which we should have no doubt, would then augment the treasures of our physical knowledge!

2. The regeneration of fresh water worms presents us with the same phenomena as that of the earth worm, and their structure is likewise very much compounded. Several species of them are principally distinguished by their colour. All of them do not possess in the same degree the property of multiplying by slips. In general the polypus greatly, surpasses them in this respect; perhaps because its structure is more simple; and it may also be owing to its having a more ample provision of germs. Be that as it may, when we cut off the bead or tail, from the worms we are treating of, they do not tbemselves become worms; but all, or the greatest part of the intermediate pieces, how small soever they be, very easily regenerate themselves, and in a short time produce an equal number of complete worms.

Regeneration begins by a little pulling up of the anterior extremity: this puffing seems analagous to the vegetable roll. The wound closes and quickly consolidates. A little bud appears in the centre of the roll. This bud increases in size and length by degrees. New rings and new viscera begin to appear. You see from the rest what is to follow.

You also very easily comprehend after what manner each piece vegetates of itself. It has in miniature the same viscera as the whole exhibited at large. You have not forgot that the parts essential to life are here dispersed throughout the whole body, and that circulation is performed in

the smallest pieces as in the whole worm.

Little buds or tubercles sometimes rise on the bodies of these worms, and give room to think that they are young ones growing from them, slips resembling those of the polypus, having the same origin and end. This species of worm, from certain pieces of which a tail shoots forth in the part where a head should have been produced, affords a very singular phenomenon, which the frequency of it does not permit us to consider as the mere effect of chance. It also proceeds less from chance than the production of this supernumerary tail. It is too well organized not to have the same origin as that which shoots forth at the posterior extremity. But we cannot pretend to say what are the causes which here determine a tail to take the place of a head. We only know, that this kind of worm is very much exposed to the loss of its hind part; it is therefore, in all probability, furnished with more means for repairing this loss, than that of the fore part.

3. it would seem as if nature had proposed to herself a kind of diversion in the formation of insects. She has lavishly bestowed on them members and organs, which she has distributed but sparingly to other animals; to one she gives two hundred legs; to another twenty thousand eyes; to a third, several hundred lungs, &c. The production of new legs, new rings, a new head, and a new viscera, seem in these instances to be attended with no greater labour or difficulty than the productions of new hairs or new feather.

She often likewise disguises the same insect, and presents it to successively under such opposite forms, that they seem to many distinct beings. This leads to the metamorphosis of insects

4. We have had frequent occasion to acknowledge, that the proceedings of nature are not always uniform, and that she can accomplish the same end by very different ways. Look at this little, oblong black, smooth, and shining cone. It most resembles those cones which many insects construct to metamorphose themselves into. However, it differs from them in some essential particulars. View it through a microscope; you will then percieve in it some annular incisions, but not very deep, which discover to you its true nature, and at the same time informs you, that it is nothing but the skin of a worm, which is become round, and has contracted a hardness. Open it gently with the point of a needle, you find nothing in it but a kind of pap, in which you are able to discover nothing. The insect has but lately lost its form of a worm; how has it been reduced into that soft substance How will that become an insect Suspend your questions, and open a cone that is less recent than this. What do you discover in it A little mass of oblong, whitish flesh, in which you cannot perceive, even through a magnifying glass, the least signs of members or organs. In a word, you have before you an oblong ball. Do not imagine that this ball is a case that contains a nymph: it is itself a nymph that is much disguised. Press the ball a little: the legs begin now to show themselves: they come out of a little socket, that is at one of the extremities of the ball. Augment the pressure by degrees; you will force all the parts of the nymph to appear. They therefore exist already: but they were sunk and infolded within the ball, almost as the fingers of a glove might be in the hand of a glove.

If you could make the same experiment on the oviform bodies of net-polypuses, and on the buds of arm-polypuses, that you have lately made on the oblong ball, you would probably oblige the little polypus to produce itself, and by that means accelerate the time of its birth.

5. Insects that pass through the state of an oblong ball can therefore form themselves a cone of their own skin. All the parts of the nymph separate themselves by little and little from this skin. It grows round and hard about them; and under this singular arch they make an end of perfecting themselves. They are at first only of the consistence of a pap. This thickens by degrees. It assumes the form of an oblong ball; and when all the members of the nymph have acquired a certain consistence, they issue one after another from the inside of the ball, and arrange themselves like those of other nymphs. By becoming a kind of cone, the skin of the insect does not lose in all the species, the form that was proper to the worm; some of them preserve it so well, that the metamorphosed worm scarcely differs at all from the worm that has not been yet transformed.

6. A hen that should, lay an egg as large as herself, from which a cock or a hen would be hatched, may offer to us such a prodigy, as we should find some difficulty in believing. A fly that is trouble. some to horses, and whose form has caused it to be named the spiderfly, affords us such a prodigy; and it should not seem the less strange, because it takes place only in an insect. Where there a law in the organical kingdom, to which we knew no exception, it would assuredly be that which ordained every organized body to grow after its birth. Nevertheless, here is a fly that lays a species of egg, from which is produced another fly as large and as perfect as the mother. This egg is almost round, white at first, and afterward of a black or ebony colour. The shell is firm and polished-but I must undeceive my reader: this is not a real egg, but has only the appearance of one; it is the insect itself that has assumed the form of an oblong ball in a cone made of its own skin. The thing is not the less wonderful on that account. All insects that metamorphose themselves, go through their various transformations, out of the belly of their mother. They are indeed to grow considerably before they undergo their first transformation, but do not grow at all afterward. We have an insect that transforms itself in the very belly of its mother, and acquires no farther growth after it has issued from it.

These cones of the spider-fly, these pretended eggs have been opened at different times; and in them have been found the same things that are discerned in the oblong ball-nymphs, when observed at their different ages. Moreover, there have been discerned stigmata in this species of cone that might be taken for a real egg, which is an evident proof that it was the skin of a worm that has transformed itself under this very skin. An egg is without motion: our cone has some that are very visible, and in certain circumstances the inside admits of their being seen, which attracts the attention of the observer. He seems to discern little clouds that succeed each other without interruption, and that pass with a progressive and uniform motion, from one end of the cone to the opposite one. In the cones that are laid before the time, these shadowy layers have a contrary direction from that which they have in the cones at the full time; You have seen that the circulation varies its course in the nymph; since our shadow layers change their’s likewise, they pretty clearly indicate to us, that the abortive cone is the worm itself, that has not yet gone through its metamorphosis. This worm, is in truth, a very singular being; it has neither head, mouth, nor any member: it is in appearance nourished like the eggs of birds, in the trunks that enclose them. A nice dissection demonstrates the ovary of the fly and the worm lodged in the middle.

7. When animals were divided into viviparous and oviparous, it was thought that all the species were comprehended. The fretter came first to clash with this famous division, and Convinced us that an animal was at the same time viviparous and oviparous. The arm-polypus next appeared, and presented us with an animal, that multiplying by slips, might with good reason be called

ramparous There have even been observations made which seem to prove that it is likewise oviparous. Another species of polypus, that multiplies also by slips, and is extremely well characterized by a sort of plume, lays her eggs. These eggs may be preserved in a dry place for the space of whole months, like the seed of silk-worms ; and if after ward sown in water, there will be produced from them as many polypuses. The bulb-polypuses may be depicted by the epithet of bulbiparous. But bow shall we describe the multiplication of other cluster-polypuses, that of the net-polypuses, and of the millipes Lastly, the spider-fly presents us with another method of multiplying, in which there is nothing that is common with any of those above mentioned, and which is attempted to be expressed by the term of nymphiparous. How many other methods of propagating will there be discovered every day for which it will be necessary to create new terms!

8. One animal does not differ more from another than a worm from a nymph. And what renders this metamorphosis still more surprising, is, that it seems to be performed instantaneously.

What then is the procedure of nature in this respect She ia other instances advances by degrees. An insensible developement brings all organized bodies to a state of perfection. Can this law, which is so universal, suffer any exception A fact which I am going to relate, will help us to penetrate this mystery.

Let us confine ourselves to caterpillars; they are sufficiently known to us, since the silk-worm is a real caterpillar. The caterpillar from time to time changes his skin, and that is common to him and most other insects. These moultings are termed maladies in the silk-worm, and they are so in effect. But it is very material to observe, that the skin which the caterpillar casts off at each moulting, is so complete, that it seems to be of itself a real caterpillar. There are found in it a head, eyes, a mouth, jaws, legs armed with hooks, stigmata, and generally all the external parts proper to the insect.

How is the caterpillar enabled to divest itself of so many organs, and clothe itself with new ones resembling the first Nothing can be more simple than this: new organs were lodged in the old ones, as in so many cases or sheaths. In changing its skin, the caterpillar had occasion only to draw them away, and drew them away accordingly. because the cases proved too strait. This jointing is so real, that it may be perceived by the naked eye. it may even be demonstrated by a very easy experiment. If, on the approach of the moulting, we cut off the former legs of the caterpillar she will issue from her spoils without any legs at all. Thus this caterpillar, which we considered as a simple and singular being, wassome measure, a multiplied being, or composed of several similar beings joined into each other, and that successively unfold themselves.

9. Hence arises a very probable conjecture: may not the chrysalis be lodged under the last skin the caterpillar is to cast off May not this skin be a mask that conceals it from our sight A celebrated observer has, by a decisive experiment, assured himself of the truth of this conjecture. He has removed the mask, and has by this means discovered the chrysalis in a manner very easy to be distinguished. He has seen the six legs of this chrysalis to grow out of the six former legs of the caterpillar, and all the other members of the latter to be wrapped together under different parts of the former. The metamorphosis of insects, then, enter anew into the order of developements and confirm it. The chrysalis, or rather the butterfly, for it is in the strictest sense but a swaddling butterfly; the chrysalis, I say, pre-existed in the caterpillar, it does no more than unfold itself in it, and the caterpillar is a kind of machine prepared for performing afar off this developement. It is in

some respects, to the chrysalis, what the egg is to the chick.

10. In truth an insect that must moult five times before it is invested with the form of a chrysalis, is a compound of five organized bodies, enclosed within each other; and nourished by common viscera, placed in the centre. As the bud of a tree is to the invisible buds it encloses, so is the exterior part of the caterpillar newly hatched to the interior bodies it conceals in its bosom. Four of these bodies have the same essential structure, and this structure is that which is peculiar to the insect in the state of a caterpillar. The fifth body, which is very different, is that of the chrysalis. The respective states of these bodies are in proportion to their distance from the centre of the animal. Those that are the farthest off have more consistence, or unfold themselves soonest. When the exterior body has attained its full growth, the interior, which immediately follows, is considerably unfolded. It soon finds itself lodged in too narrow a compass. It stretches on all sides the sheaths that encompass it. The vessels which convey the nourishment to these coverings, being broken or stifled by this violent distention, cease to act. The skin wrinkles and dries up. At length it opens. and the insect appears clothed with a new skin and new organs. A fast of a day or two precedes each moulting. It is probably occasioned by the violent state in which all the organs then are.Perhaps it might be also necessary in order to promote the success of operation, and prevent obstructions. Be this as it may, the insect weak after every moulting. All its organs are yet affected by state they were in under the covering they are just disengaged from The scaly parts, as the head and legs, are almost entirely nous, and are all imbued with a liquor that insinuates itself betwixt the two skins, and facilitates their separation. But this moisture evaporates by degrees: all the parts acquire a consistence, and the insect is in a condition to act. The first use that some species caterpillars, which live only on leaves, make of their new teeth, it to devour greedily their spoils: sometimes they will not even wait for doing it, till their jaws have received their full degree of strength Can these spoils be a proper ailment to renew and increase their strength Some caterpillars have likewise been seen to gnaw the shells of their eggs after they have issued from them, and even that of the eggs of such caterpillars as have not been hatched.

11. When we have once conceived that all the exterior parts of the same kind are jointed into each other, or laid one on another, the production of new organs has nothing embarrassing in it; and with regard to this, there is not any essential difference betwixt the five moultings that precede the transformation. Nothing more is requisite in all that, but a simple developement. But it is not absolutely the same with respect to changes that happen in the viscera before, during, and after the metamorphosis. Here the light that should guide us is almost extinguished, and we are constrained to grope in the dark.

It does not appear that the insect changes its viscera as it does its skin. Those which existed in the caterpillar, exist likewise in the chrysalis; but they are modified, and it is the nature of these modifications, and the manner by which they are performed, which elude our researches. A little before the metamorphosis, the caterpillar rejects the membrane that lines the inside of the intretinal bag. This bowel which has hitherto digested gross food, must hereafter digest that which is extremely delicate. The blood that circulates in the caterpillar, from the hind part towards the head, circulates a contrary way after transformation. If this inversion be as real as observations indicate, what idea does it not give us of the changes the inside of the animal experiences Those which the circulation of the blood in a new born infant undergoes, are in a manner nothing in comparison of them.

12. Whilst nature is labouring to change the viscera, and to give them a new life, she is employed at the same time in the developement of divers organs, which were useless to the insect while it lived under the form of a caterpillar, and which the new state. whereunto it is called renders necessary for it. The better to ensure the success of her. different operations, she causes the insect to fall into a deep sleep, during which she carries on her work at leisure and by insensible degrees. The little wounds which the rupture of several vessels has occasioned in divers parts of the inside, consolidate insensibly. Those parts which had been put into a violent exercise, or whose forms and proportions had been modified to a certain degree, conform themselves gradually to these changes. The liquors which are obliged to pass through new channels, take that direction by little and little, Lastly, the vessels which were proper to the caterpillar, some of which occupied a considerable place within it are effaced or converted into a liquid sediment, which the butterfly rejects after having laid aside the sheath of the chrysalis.

13. When we consider the metamorphosis of insects, we are surprised at the singularity of the means which the Author of nature has thought proper to make choice of, in order to bring the different species of animals to perfection.

Wherefore is the butterfly not bred a butterfly Why does it, pass through the state of a caterpillar, and that of a chrysalis Why do not all the insects that metamorphose themselves undergo the same change Whence does it happen, that amongst the species that assume the form of a nymph some shed the skin of a worm, whilst others retain it How does it also come to pass that among such insects as pass through the state of the worm skin nymph, some take that form in the very belly of their mother

These questions, like all those which may be started concerning essences, derive their solution from the general system which is unknown to us.

Without endeavouring then to penetrate into the cause of metamorphosis, let us observe attentively the fact, and its immediate consequences.

Let us consider the variety which those metamorphosis disperse throughout nature. A single individual unites within itself two or three different species. The same insect successively inhabits two or three worlds ; and how great is the diversity of its operations in these various abodes!

Let us also remark to what degree the relations which the fly or the butterfly maintains with the beings that surround them, are multiplied by their metamorphosis. Let us fix our attention on the cone of the silk-worm; and admire what a number of hands and machines this little ball sets to work. What prodigious riches should we have been deprived of, had the butterfly of the silk-worm been originally produced in that form

Insects that undergo transformations have not yet afforded us and species that multiplies by slips and shoots. This will not surprise us, when we reflect on the great composition of the bodies of these insects. But let us not be too hasty in our judgment, nor conclude that the property of multiplying by slips arid shoots is incompatible. with metamorphosis. Nature is too little known to us, to give us a right to form such conclusions. Vine-fretters and polypuses have furnished us with good preservatives against too general conclusions.

Chapter 10 - Parallel Between Plants and Animals

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1. In our researches into the gradual progression of beings and organical economy, we had frequent occasion to compare vegetables and animals with each other. Let us here collect in one view', those various marks of analogy which are scattered hither and thither: let us represent' them as in a picture, wherein by a nearer description of them, they will agreeably attract our attention. We will afterward inquire if there' be any character which essentially distinguishes the vegetable from the animal.

2. A seed is an organized body, which under various coverings, thicker or thinner, and more or less numerous, contains within it a plant in miniature. A whitish substance, of a spongy nature, fills the capacity of the seed. Small vessels which proceed from the germ, are in every part of this substance, dividing and sub-dividing it. After being laid in the earth, moistened and warmed to a certain degree, the seed begins to shoot up. The moisture which has penetrated its outward folds, dissolves the spongy substance and mixes with it. Of this mixture is formed a kind of milk, which being carried to the embryo by the little vessels, furnishes it with a nourishment adapted to its extreme delicacy. The radical or little root' begins by this means to' unfold itself. It increases in bulk and extent every day. In a short time it becomes sensible of too close a confinement: it makes an effort to come forth. A small orifice, made in the exterior surface of the seed, facilitates its egress. The root insensibly sinks into the earth, and derives from thence more substantial and copious nourishment. The small stalk, which till this time lay hid under the coverings of the seed, now begins to show itself. The tegunrents unfold themselves in order to admit a free passage for it Strengthened by an accession of fresh juices. it pierces through the earth, and advances into the air.

3. An egg is an organized body, which under divers teguments, of various strength anti number, encloses an animal in miniature. A fluid matter of a glutinous nature, fills the inside of the egg. A number of infinitely small vessels spread themselves out in this matter, and are connected with the germ by different branches. Being warmed in a sufficient degree, either by nature, or art, the inside of the egg begins to receive life. By means of a gentle heat, the matter surrounding the germ insinuates itself into the small ramifications, from whence it passes into the heart, whose motion it augments. Thus the animal becomes a living creature. It increases in size and strength every day, by receiving fresh supplies of more nourishing and perfect juices. After these juices are exhausted, the animal has acquired all the growth it was capable of in the egg. It finds the apartment assigned it to be too narrow. It endeavours to set itself at liberty. Nature has provided it with an easy method of effecting this, either by arming it with instruments proper for piercing or tearing the coverings which enclose it, or by giving to the egg such a structure as favours its efforts. The animal is produced, and enjoys a new life.

4. The seed then is to the plant what the egg is to the animal. But the plant is not only oviparous but also viviparous; and the foetus is the same with respect to the animal, as the bud is to the

vegetable. Being concealed under the rind, the bud there receives its first growth. It is minutely inclosed in membranous teguments, analagous to those of the seed. It adheres to the bark by small fibres, which transmit a nourishment to it, adapted to its state. When it has arrived to a certain bulk, it penetrates the rind in order to come forth. At its first appearance, it bears the infolding coverings along with it, from which it is soon released. However, being as yet too feeble to subsist without the aliment provided by the mother, it continues to cleave to her; and cannot for a long time be separated without endangering it. Being lodged in the matrix, the foetus there receives its first growth. It is there contained at first in miniature, in the membranous enclosures resembling those of the egg. It shoots forth small vessels in the matrix, which conveys thither the nourishment necessary to promote its growth. When it has arrived to a certain size, it bursts the enclosures, and comes into the world. Some times the enclosures accompany it at its issuing forth. After it is produced, the little animal is not always able to provide for itself without the assistance of the dam. She must still furnish it with sustenance which it cannot dispense with, for a certain time without danger.

5. The plant is nourished by the incorporation of substances, received from without: these matters are very heterogeneous. Being pumped by the pores of the roots, or by those of the leaves, they are conveyed into the utriculi, where they ferment and digest. They pass into the ligneous fibres, which transmit them to the proper vases, where they appear under the form of a juice, which is or less coloured. The ramifications of the proper vases afterward distribute them into all the parts, to which they are united by new filtrations.

Tubes made of a silvered blade, which are elastic, and turned spirally like a spring, accompany the vessels which contain the sap in their course. Being appointed for the purpose of respiration, these tubes introduce a fresh elastic air into the plant, which prepares and subtilizes the sap, and probably colours it, besides contributing to its motion: the superfluous matter, or that part which is not so proper to be mixed with the plant, is conveyed to the surface of the leaves, whence it evaporates by in insensible, but very copious transpiration, Globules. vesicles, or other excretory organs, which are distributed among the young shoots or leaves, procure an evacuation of the grosser matter, anti such as is of a stronger consistence. The animal is nourished by the incorporation of matter which proceeds from without. This matter is very heterogeneous. Being received by the mouth, it is conveyed into the stomach and intestines, where it undergoes different preparations : it passes into the lacteal veins and their dependencies, or in other like vessels, whereby it is transmitted into the blood vessels, where it appears under the form of a fluid more or less coloured, or flowing. The ramifications of the blood vessels afterward disperse it into all parts, with which it incorporates itself by new preparations.

Pipes composed of cartilaginous rings, or of a silvered and elastic blade, turned spiral wise, communicate with the blood vessels, or follow them in their course. As they are appropriated to respiration, they introduce into the animal a fresh and elastic air, which prepares, attenuates, and probably colours the blood, contributing likewise to its motion. The superfluous matter, or such part of it as is improper to be united with the animal, is carried to the surface of’ the skin, from whence it evaporates by an insensible, but very copious transpiration. Glands, or other emunctory organs, placed in different parts of the body, procure the evacuation of the grosser matter.

6. The plant grows by unfolding, or the gradual extension of its parts in length and width. This extension is followed by a certain degree of hardness contracted by the fibres. It diminishes as the hardness increases. It entirely ceases when the fibres are so far hardened as not to yield to the force which tends to enlarge their surface. The plants which become hardened the latest, are those which are the longest time in growing. Herbs grow and harden faster than trees. Some of them cease to grow at the end of a few weeks, or even a few days. Among the last, some continue to grow for a great number of years, and even for ages.

We observe analogous differences between individuals of the same species. Some harden sooner, grow in a less degree, or continue smaller; others harden later, anti become larger. The bud has nothing ligneous or woody in it. Being herbaceous in every part of its substance, it becomes ligneous by degrees. Its stalk is formed of a prodigious number of concentric blades one in another, which are disposed according to its length, and compose different bundles of fibres, which are themselves formed of a prodigious number of lesser fibres. At the centre of the stalk is placed the pith ; and the spaces which are left between the blades, are likewise filled with a pithy substance. From the thickness of the blades results its growth in width ; from the lengthening of the blades its growth in length proceeds. All the blades grow and harden one after another. Every blade grows and hardens alike successively throughout its whole length. That part of every blade which grows and hardens first of all, is that which composes the base of the stalk. The blade which grows arid hardens first, is !he innermost, or that which immediately encompasses the pith. This blade is again covered with another, which being more ductile extends itself the more. A third blade encloses this last, which as it hardens still later, is a longer time in its growth. The case is the same with regard to a fourth, fifth, or sixth. All these thus diminishing in thickness, and inclining towards the axis of the stalk, as they approach its upper extremity, form so many little cones engrafted into each other from whence proceeds the conic figure of the stalk and branches. From the assemblage of little cones which become hardened during the first year, is formed a cone of a woody nature, which determines the growth of that year. This cone is enclosed in another herbaceous cone, which is only the rind, and which the following year will produce a second ligneous cone, &c. When the wood is once formed, it does not extend itself any farther. So that in cicatrices, grafts, and different kinds of tumors, the rind is the only part that is employed. By stretching, thickening, or swelling itself, the rind insensibly forms a roll, an(l produces excrescences which are more or less considerable, in proportion to the ease with which it is distended, or according to the quantity of juices it receives.

7. The animal grows by expansion, or by the gradual extension of its parts in every sense. To this extension there succeeds a hardness in the fibres. The extension diminishes as the hardness increases. It ceases when the hardness has arrived to such a pitch, as not to admit of the fibres giving way to the force which contributes to enlarge their coats.

Those animals, in which this hardness is formed latest, are longest in their growth. insects grow and harden in a much less time than great animals. Some of them cease growing at the end of some weeks and sometimes in a few days. Of the latter, some continue growing for a great number of years, and even some ages.

One may observe analogous differences in the growth of individual of the same species: some of which that harden later than others acquire a greater bulk. The foetus, in its original state, contains

nothing of a bony nature As it is membranous throughout, it only becomes bony by degrees ‘The bones are composed of a prodigious number of blades, folded in each other lying according to the length of the bone, and forming various collections of fibres, which are themselves composed of the reunion of a great number of little fibres. In the centre of the bone is placed the marrow. The spaces between the blades are filled with a medullary substance. From the thickening of the blades the growth of the bone proceeded From the lengthening of them, their extending in length. All these blades grow and harden after one another. Each blade grows and becomes hard in a like successive manner throughout its whole length That part of the blade which grows and hardens first, composes the body of the bone: which immediately encloses the marrow. This blade is again covered with a second, which being more ductile, stretches itself in a greater degree. A third blade again enfolds this, which as it hardens later than the others, is a longer time in its growth. It is the same with respect to a fourth, fifth, or sixth. As they all thus diminish in thickness, and detach themselves from the axis of the bone, the nearer they approach to its extremities, they form so many little columns, infolded within each other, which increase in diameter at their extremities. From hence we deduce the figure peculiar to long bones. The growth of the hone during the first year, is attributed to the number of blades which become hardened in that year. This bone ‘is covered over again with a great number of membranous blades., that hear the name of periosteum, which as they gradually extend and harden, conduce to the increase of the bone in every part of it. The bone when it is once formed, extends itself no farther.

Thus in fractures, anchyloses, and the different species of excrestences, whether natural or accidental, the periosteum is the only part of the bone that labours. By stretching, thicking or swelling itself, the periosteum restores to the bone insensibly, produces a callosity, and forms greater or less tumors, in proportion to the facility wherewith it extends itself, or as it is more or less supplied with juices, or with such as are more or less viscous.

3. The dust or fine powder of the stamina, is the principle which fertilizes the seed. The pistil is the place where this fecundation is performed. Being contained in certain vesicles, the fecundating dust is discovered in them by a microscope, under the appearance of a group of minute, regular bodies, for the most part of a spherical or elliptic form, which being moistened, open themselves, and emit a thin vapour, in which there floats a great number of exceeding small sees, which seem to move on all sides. The dust itself, when dropt j11tO water, moves several ways with great rapidity. The pistil is composed of three principal parts the base, the cups. and the top. The base contains one or more cavities, where the grain is lodged. The cups are long funnels, whose base or aperture it turned towards the top. This is generally furnished with several nipples each of which is perforated, having their diameter corresponding with that of a small grain of the dust. Being in the tower part of the cup, the minute grains are pressed in them more and more by the straitness of these pipes. They are ‘therein moistened with a juice that lines their sides. They open themselves and eject the seminal vapour, which penetrates to the peed, and promotes fecundation.

Several- species of plants have two sorts of individuals, viz. 1. Such individuals as only bear stamina, and these are males; and two individuals that have only the pistil, which are females. In a great number of species, every individual is an hermaphrodite, which unites both sexes, the stamina and the pistil. Sometimes this union happens in the same flower ; then the stamina surround the pistil. At other times it is only effected on the same branch; so that the stamina are

placed on one part, and the pistil on another.

9.The seminal liquor is the principle of fecundation in the egg. The matrix or ovaries are the places where it is performed. Being enclosed, in' the seminal vessels, the fecundating liquor appears in them, through a microscope, like a mass of small regular bodies of different lengths, which seem to separate themselves into a great number of extremely minute grains, moving different ways Sometimes these corpuscles resemble cases with springs, which when moistened, open themselves, and dart forth a limpid matter abounding with a great number of very small grains. The matrix consists of three principle parts, or dependencies; the fundus or bottom, the fallopian tubes, and the ovaries. The fundus contains one or more cavities, in which the embryos receive nourishment and expand themselves: it has an orifice in the fore part. The fallopian tubes are a kind of long funnels, whose aperture is directed towards the ovaries, where it ends. The ovaries are a mass of vesicles that are real eggs. When the most subtle part of the seminal liquor has arrived through the fallopian tubes to the ovaries, it there fecundates one or more eggs. These afterward descend by these tubes into the matrix, where they are fixed and unfold themselves. In oviparous females the eggs are contained in a kind of bowel, wherein they receive their growth: the seminal liquor makes them fruitful.

Most animals consist of two sorts of individuals; male and female But there are other species, of which every individual is an hermaphrodite, which unites the two, although it cannot fecundate itself. In some species, where a distinction of sexes is observed, there is no coupling, properly so called; the male only communicates his liquor to the eggs which the female has deposited. Finally, some species are propagated without any apparent or external fecundation.

10. A plant does not only multiply by seeds and buds; it is like wise propagated by suckers and sprigs. It may also be multiplied by slips, and by ingrafting. A tree sends forth small buds from various parts of its surface. These buds increase in bulk; they open and disclose the shoot; which extends itself every day. While it is expanding itself, other still smaller sprigs shoot from it. These in their turn are succeeded by lesser ones; all of which are so many trees in miniature; and the nourishment received by one of these sprigs is communicated to the whole plant. When it has attained to a certain size, and is separated from the trunk, either by nature or otherwise, these shoots sustain themselves, and become so many distinct trees. Being cut into pieces according to their width, or even their length, these shoots will grow again of themselves, and will become as many trees as they were made slips of.The leaves themselves when separated from their shoots, may afford so many complete plants. Being fastened closely to each other, or inserted in one another, several of these shoots, whether taken from the same or from different individuals, will unite together in so intimate a manner, that they will receive reciprocal nourish. meat, and form one individual whole. The animal is not only propagated by eggs and living young, but likewise by shoots. It may also be multiplied by slips and ingrafting. A polypus sends forth little buds from different parts of his body. These buds grow big and lengthen insensibly. Every one of them is a young shoot. While it is unfolding itself, there springs from it other smaller shoots. These in their turn produce smaller still. All these shoots are so many little polypuses, and the nourishment one of these polypuses receives, is communicated to their whole number. When they have arrived to a certain size, they separate themselves from the trunk, and become so many individuals. Being cut into little bits, either transversely or lengthwise, the polypuses grow up again from the ruins, and become as many complete ones as they were pieces. The very skin, or even the least fragment of

them, is capable of affording one or several polypuses.

11.The generation of vegetables is not constantly regular. The laws by which they operate are sometimes infringed. Prom them arise various species of monsters. Sometimes they are compounded leaves, whose smaller ones are more or less numerous, or more irregularly shaped, or distributed with less symmetry than usual. Sometimes there are flowers which have neither stamina nor pistils, and whose petals being greatly multiplied, seem to have absorbed these essential parts. Sometimes two fruits cleave together by a natural graft or are enclosed in each other. Sometimes there are flowers or fruits whose form differs widely from that which is peculiar to the species. Lastly, there are productions which do not properly belong to any particular species, because they derive their original from seeds that have been fecundated by dust of a different species. The generation of animals is not constantly regular: the laws by which it is governed, are sometimes disturbed; whence are produced the different species of monsters. Sometimes there are hands and feet, whose fingers or toes are fewer or more in number, or formed in an irregular manner, or otherwise disposed than usual. Sometimes there are foetuses, in which the parts of generation are obliterated. Sometimes there are two eggs or two foetuses that cleave to each other by a natural cohesion, or that are contained in one another. Sometimes there are eggs or foetuses whose form is greatly different from that which is pepuliar to the species. Lastly, there are productions that partake of two species, because they are produced from such females as are fecundated by males of different species.

12. The laws respecting the nutrition and growth of vegetables are liable to greater disorders than those of generation. From hence are derived the different kinds of maladies the plant is subject to. Some of these maladies only attack the leaves, and produce on them spots of different colours, wrinkles, pustules, scabs. Others attack the principal viscera, and occasion choakings, obstructions, stagnations, tumors, cancers, effusion. Others take their seat in the flower or fruit. Others affect the ligneous bodies, which they cause to moulder away, whilst the bark remains whole. Others come from little plants or divers insects, which being on the outside or inside of vegetables, convert their nourishment to their own advantage, or change the organization of it. Others derive their origin from a change of climate, aliment, or culture. The laws of the nutrition and the growth of the animals are more frequently disturbed than those of generation. From hence proceed the various species of disorders to which an animal is exposed. Among these maladies, there are some which attack only the skin, and produce spots of various colours, wrinkles, pustules, pimples. Others attack the principal bowels, and occasion oppressions, obstructions, stagnations, tumors, abscesses, overflowings. Others are seated in the organs of generation. Others seize the bones, and beget rottenness in them, whilst the periosteum continues sound. Others have their source from different insects, which, being lodged either without within the animals, divert the nourishment of them to their own fit, or alter the constitution of them. Others are caused by the change of climate, nourishment, or breeding.

13. Finally, the plant after having escaped a variety of maladies which threatened its life, cannot elude the effects of old age, that creeps into it, nor the stroke of death, the inevitable consequences of it. Being hardened by time, the vessels lose their exercise, and are stuffed up. The liquors contained in them no longer move with the same facility, nor continue to be filtrated and pumped out with the same precision. They stagnate and corrupt; and this corruption being soon communicated to the vessels that enclose them, the vital functions cease, the plant dies and

crumbles into dust.

Lastly, the animal, after having been preserved from those diseases which conspired against him, cannot escape old age, nor death that follows in his train.

When, the vessels are grown hard through time they lose their action and are stopped up. The liquors do not circulate in them with the same degree of quickness, and they are filtered and pumped up but in a very imperfect manner. They stand still and are altered, and this alteration soon communicating itself to the vessels that Contain them, circulation ceases, the animal dies, and is reduced to dust.

14. We have carried the parallel between plants and animals from their birth to their death. The parts of which they consist, very evidently establish the great analogy there is betwixt these two classes of organized bodies. But there are other sources of comparisons, we have either avoid ed to dwell upon, that we might not render our description confused, or have only slightly touched upon, under certain points of view. Such are those presented to us by place, number, fecundity, form, structure, circulation of liquors, locomotive faculty, feeling, and nutrition.

We will take a transient survey of these sources, and without endeavouring to exhaust them, content ourselves with barely pointing out their most remarkable and characteristical contents.

Vegetables and animals reside in the same dwelling-place. Being appointed to people and adorn our globe, they are dispersed over its whole surface, and are placed near each other, in order to enable them to afford a reciprocal assistance. Like two great trees growing in the same soil, the animal and vegetable kingdoms entwine their branches together and extend their boughs and roots to the extremity of the world The outside and inside of the earth, mountains and vallies, barren and fertile places, countries undiscovered and bid in dark obscurity, the region is of the north and south, rivulets, rivers, ponds, lakes, and seas, have their vegetables and animals.

Many species of plants and animals seem to thrive alike in different climates. Other species are amphibious, and live as well out of the water as in it. The bulrush and frog flourish in meadows, and at the bottom of ponds. Others are parasites, and are nourished by the juices they extract from different species. Such are the misletoe and the louse.

Lastly, some parasite species supply their necessities, in their turn, from other parasites. The misletoe has his liverworts, and certain lice have their lice.

15.There are upwards of twenty thousand species of plants known to us, and new discoveries of them are made every day. A microscopical botany has extended the dominions of the ancient. Mosses, mushrooms, liverworts, whose families are innumerable, now take place amongst vegetables, and present the curious with flowers and seeds which before they were unacquainted with. The microscope discovers plants to our view, where we never suspected them. Freestone is often covered with spots of different colours, commonly brown or blackish. Glass, notwithstanding its fine polish, is not exempt from such spots. We observe hoariness on almost all bodies. These spots and this hoariness are found to be gardens, meadows, and forests in miniature, whose plants that are infinitely small, afford us nevertheless some prospects of their flowers and seeds. But although vegetables are very numerous in their species, yet they are much less so than animals. Emery species of plant has not only its particular species of animals, but there are many

species of plants which nourish several species of animals. The oak alone finds nourishment for above 200 species of them. Some attack the roots of this tree, which they dig into, and produce therein various tuberosities. Others fix themselves in the trunk, where they make crooked furrows. Some insinuate themselves into the bark and wood: whilst others penetrate the interior parts, whence they extract the juice Some feed only on the leaves. Others fold or roll them up with a great deal of art. Some form them into nuts. Others find both lodging and nourishment in the fruit. Nay, gather but a flower by chance, either a daisy, poppy, or rose, and you will observe on it a multitude of insects. In short, where can we turn our eyes without beholding animals Nature has strewed them every where with a bountiful hand. They were her most excellent productions; she has been liberal of them. She has inclosed animals within animals; she has ordained one animal to be a world for others. which should find therein nourishment in proportion to their wants. The air, vegetable and animal liquor corrupt matter, dirt, dung, dry wood, shells, and even stones, and all animated, all swarm with inhabitants. What do I say The itself sometimes appears to be one entire collection of animals. The light, which glitteringly reflects on it in the night-time, during hot weather, is produced by an infinite number of very minute glow. worms, of a yellowish brown colour, and soft substance, not caterpillars, every part of which, after being divided, and even putrefied, shines with the same brightness as when the worm was whole and living. A species of sea-flies are also luminous, and communicate their lustre to the waters. There issues from within them a globular matter, which is likewise phosphorous.

Herbs are more numerous in their species and individuals than shrubs and trees. Insects are more numerous, in respect to their: species and individuals, than birds and quadrupeds. There are more ranuneuluses than rose-bushes, and more blades of grass than Oaks. There are more butterflies than fowls, and more vine-fretters than dogs.

16. The magnificence of the creation shines in no part of it with greater lustre, than in the prodigious fecundity of a great number of plants and animals. One single individual may give birth to thousands, or even millions of individuals like itself. Being formed agreeable to those proportions which are only known to that adorable Wisdom that' has established them, this great people was at first enclosed within the narrow compass of a rind or ovary. In this dark abode they receive their first life, begin to grow, and are disposed to appear on the mast theatre of the visible world.

If we consider things in a general view, vegetables will be found to be more fruitful than animals. We shall be farther convinced of this, by comparing trees with quadrupeds.

Trees produce annually, sometimes for many ages, and their productions are always very numerous. Large quadrupeds, as the elephant, the mare, the hind, the cow, &c. have seldom more than one at a time, rarely two, and the number they breed is always very moderate. Lesser quadrupeds, such as the dog, the hare, the cat, the rat, increase in a much greater degree; but their fecundity is but inconsiderable, when compared to that of ligneous plants. The elm produces yearly upwards of three hundred thousand seeds; and this astonishing multiplication may continue above a century.

Fishes and insects nearly resemble vegetables in fecundity. A tench lays about ten thousand eggs; a carp about twenty thousand; and a cod, a million. An insect which produces the itch, lays four or five thousand eggs; a female bee, forty-five or fifty thousand. To this amazing fecundity is

opposed that of the wild poppy, mustard. fern. And we must not forget, that most vegetables are propagated different ways; whereas, animals are for the most part propagated only by one. A tree may be made to form as many trees as it has branches, boughs, and even leaves. Plants, which are principally designed to supply the necessities of animals, cannot be endued with too great a degree of fecundity.

17. There is hardly any sight more interesting than that whichinfinitely varied forms of plants and animals afford. If one compares the less perfect species with the more perfect, or the species of the same class with each other, he is equally struck with the diversity of models, by which nature has performed her works in the vegetable and animal kingdoms. He passes with astonishment from the swinebread to the sensitive plant, from the mushroom to the carnation, from the nightshade to the oak, from the ivy to the fir tree. He considers with surprise, the prodigious multitude of mushrooms and liverworts, and can never enough admire the fecundity of nature in the production of these plants. As he goes on to plants that are more elevated in the scale, he stops with pleasure to examine those plants that have stalks, from the grass which grows between the stones to that precious plant whose ear furnishes us with the most wholesome food. He considers the various plants that creep, from the tender bind-weed, to the vine branch which crowns our hills. He likewise takes a survey of those trees which bear fruit with stones, from the wild plum tree to the peach, whose fruit does not excite our admiration more by the softness of its velvet covering and beautiful colour, than by the abundance and exquisite taste of the liquor it yields.

If from the vegetable, he transports himself into the animal kingdom, the prospect becomes still more interesting, lie sees opposed to each other in the same portrait, the polypus and sea-dog, the day. fly and flying-fish, the dancing-bird and eagle, the grasshopper and flying-squirrel, the ant and stag, the cricket and rhinoceros, the wood louse and crocodile, the scorpion and the ape.

Another picture presents him with a view of the prodigious number of butterflies and flies; in considering which he is astonished at nature’s complaisance in thus diversifying these little animals, so different from the great ones by their forms, and which have been treated as defective or imperfect beings.

Transferring next his survey to those species of animals immediately higher, he contemplates shell fish, from that whose precious liquor dyes the garments of kings, to the sailor that rows with so much grace and skill on the inconstant waves. He observes the different species of fish, from the dangerous cramp fish to the powerful nerval, and from the pretty golden fish of China, to the dolphin, that cleaver the billows with the swiftness of a dart.

He likewise takes a view of those birds that live on herbs and seeds, from the linnet, that delights us with his melody, to peacock that pompously displays in our court-yards the gold azure with which he is enriched. lie also observes the birds of prey from the fierce merlin to the eagle, whose strength courage have raised him to the sovereignty over the birds. He next reviews the quadrupeds, from the light and timorous hare to the plant, whose enormous corpulency attracts every eye, and from the wily fox to that noble and generous quadruped which seems formed to have dominion over the animal creation.

Plants, though prodigiously various in their forms, are yet less so than animals. There are fewer gradations from the truffle to the sensitive plant, or from the nightshade to the oak, than there are from the oyster to the ostrich, or from the sea-nettle to the ouran-outang. Plants being essentially more simple than animals, have not given birds to so many combinations. The forms of animals afford us a singularity which is extremely remarkable, and sufficient to distinguish them from vegetables; I mean those admirable metamorphosis which the same insects exhibit to us, which are sometimes so opposite, that it does not appear to be the same animal. But may we not compare the bud in which a plant or flower is infolded, to the covering of a chrysalis which conceals the butterfly from our sight And as the plant cannot produce seeds till the flower has issued from the bud, so neither can the butterfly propagate till it has cast off the sheath of the chrysalis.

18. It is not so easy to compare plants and animals in their interior forms or structure, as it is in their exterior. We may judge of the one by a single glance of the eye: we must bestow a particular attention to judge of the other. We penetrate with greater difficulty into the inside of the plant, than into that of an animal. The micro-scope, scalpel, and injections, which are so serviceable to us in the anatomy of animals, assist us very imperfectly in that of plants. It is likewise true, that this part of organical economy has been less studied. But how imperfect soever the anatomy of plants may be, we are able to discover some of their principal vessels. These may be ranged under two general classes: the longitudinal, that extend the whole length of the plant; and the transverse vessels, or such as are placed across it. The sappy vessels and trachaean belong to the first class; the utriculi or insertions to the second. The vessels containing the sap seem designed to convey the juice. The utriculi, or little bags appear intended for digesting it.

Some plants seem to be entirely composed of utriculi: such are certain species of roofs and sea plants. whose texture is almost together vesicular, it is the same with those animals which seem to of stomach only, as the polypus and tape-worm.

One of the principal characters by which we may distinguish insects from large animals, is, that the former have no bone within them. What they have of a bony or scaly nature is placed on their outside for a support or defence to the more delicate parts underneath, or to sustain the body with greater advantage. Thus we see that in almost all insects, properly so called, the head, corset, legs, rings, &c. are either wholly, or for the most part, doubly covered with scales.

Herbs differ from trees as insects from large animals. They haveligneous body in their centre. What they have of a ligneous nature, appears on the outside, and serves to protect the weaker parts 0f the plant. Thus we find plants with tubes are strengthened by knots placed at regular distances; so that the lowermost knots which are designed for the base, are stronger and nearer each other than the upper ones. It is on the same account that the roots of many herbaceous plants, as well as the calixes of flowers, and the capsules or coverings of the seeds, are made almost ligneous.

Herbs grow and become hard sooner than trees. Insects than great animals. Herbs and insects, being of a softer consistence than trees and large animals, extend themselves with greater ease, and sooner arrive at the period of their extension. Besides, the concentric beds of the bark of trees, and those of the periosteum of animals, being far more numerous than the relative beds of herbs and insects, must needs require a longer time for their growth.

We may distinguish two kinds of parts in organized bodies ; to wit, similar and dissimilar. The former are composed of fibres of the same kind; the latter of fibres of various sorts. The nerves, arteries, veins, lymphatic vessels are the similar parts of our bodies; the brain, heart, lungs, stomach, the dissimilar. Plants are almost entirely composed of similar parts. The vessels containing the sap, the trachaea, and utriculi, are of this kind These different vessels are pretty uniformly dispersed throughout the whole body of the plant: they enter into the composition of all its parts. They are to be met with in the root, stalk, branches, leaves, flowers and fruits The least fragment, the smallest leaf, is a representation of the whole, an abridgment of the plant.

There are likewise animals which are nearly composed of similar parts. Of this number are many species of long worms, and some aquatic millipedes, nettles, and sea-stars, polypuses, moths, earth worms. All these animals are formed in such a manner, that each part of them, even the smallest, corresponds in miniature to the whole in all parts. In the long worms I just mentioned, we observe very distinctly a stomach, a heart, and some very small vessels which seem dependent on the latter. There is likewise no room to doubt that there is beneath the stomach, a medullary string, like that observed in other species of worms and caterpillars. Their viscera are not distributed in certain regions of the body: they are universally dispersed throughout its whole length; so that we may truly affirm that these insects are brain, all stomach, all heart. But this brain, stomach, and heart appear extremely simple: the first is scarce any thing more than a nervous piece of net-work, the second a membranous bag, and the third a grand artery.

Polypuses, which are more simple in their structure, are only a kind of bowel, sown with an infinite number of small seeds, which are tinged with the colour of the aliment.

Tape-worms partake of the structure of polypuses, but seem to be more compounded. They are formed of a chain of flat, membranous, and whitish rings, joined together like the divisions of a reed. Each ring has on its upper part, or on one of its sides, a more or less sensible eminence, in the centre of which is a small round aperture, The middle of the ring is full of vessels of a purple or whitish colour, which perform a labour that attracts the attention of the observer. The rest of the ring is filled with an infinite number of small white seeds. Such is essentially the structure of the tape-worm in its whole extent; there is no perfect variety or resemblance between all the rings, the assemblage of which composes a kind of ribband or lace, which extends sometimes several hundred feet in length.

Earth-worms are, of all the insects I have mentioned, those whose inside seems to be the most compounded, chiefly because in them the two sexes are united: but the most essential organs of life are distributed in them likewise through the whole length of the animal.

Organized bodies, whose structure is so simple and uniform, that each part of them has in a small compass an organization resembling that of the whole in a greater extent, enjoy divers prerogatives that have been denied to organized bodies of a more complicated structure. The first of these are not destroyed when divided asunder. Their different portions continue to live, and the wounds which. have been given to them easily consolidate. These parts vegetate, receive nourishment, produce new organs, and multiply. Such wonders as these the vegetables and insects we have lately treated of exhibit every day; wonders which we have not sufficiently admired in the former, and which perhaps we too much admire in the latter.

Large animals do not furnish us with the same phenomena. The consolidation of their wounds, and the re-union of their fractures, although oftentimes attended with circumstances which render them very remarkable, strike us but slightly when compared with what we observe analogous in polypuses, and other insects that multiply by slips. The motions we perceive in certain parts of great animals, when separated from the body, or after the death of the animal, affect us only with a slender degree of surprise, when we consider the of different parts of worms, or those of some mellipedes. But may there not be some misconception in these different judgments We judge of the effect produced, as considered in itself, and separate from the circumstances accompanying it; whereas we should Judge of it with relation to the greater or less degree of composition whereof the body, in which this effect is produced, consists. There as much, and indeed more to be admired in the consolidation of certain wounds or in the re-union of certain fractures of our body, than there is in the consolidation of the wounds of polypuses, or in the re-union of parts which have been separated from them. A very simple machine is easily repaired; a machine that is extremely compounded, cannot be repaired with the same facility. When we reflect on the prodigious number of similar and dissimilar parts contained in the composition of the bodies of great animals, and particularly in that of the human body; when we attend to the strict connexion of all these parts, and to the degrees of composition in each of them, we cannot sufficiently wonder that the various accidents which happen to these bodies are not attended with greater consequences; we shall at the same time perceive the reason why they are not enabled to propagate like bodies whose organization is more simple. But independently of the greater or less degree of the composition of parts necessary to life, as soon as these parts are found placed in different regions of a body, and are not dispersed throughout its whole length, such a body cannot be multiplied by slips. The Author of Nature, by denying, in his wisdom, this property to large animals, by confining the sources of life in them within a narrow circle, has secured them from harm by many advantages. Compare the result of the motions or actions of a sea-worm with that of the motions or actions of an ape, and you will soon perceive which of these animals has been most favoured.

Finally, organized bodies, to which a power has been granted of multiplying by a method which seems to tend to their destruction, are such as are exposed to the greatest dangers, and whose life is necessarily threatened every moment with a thousand various accidents.

19. Amongst the motions we observe in the animal machines, that of the circulation holds the first rank, either by its importance, or its nature, duration, and the number of organs by means whereof it is performed. There is in this motion an air of grandeur that seizes forcibly on the mind, and which, by making it sensible of the narrow limits of human understanding, penetrates it with the most profound respect, and fills it with the highest admiration of the infinite mind which illustriously shines in the Divine Author of it. In the centre of the breast, between two spongy masses, known by the name of lungs, is deposited a fleshy pyramid, whose base bears two small funnels like ear-rings, which communicate with two cavities contained in the inside of the pyramid, and which divide it according to its length into two chambers or ventricles: the right Ventricle and the left. This pyramid is the heart, the main spring of the machine. It has two principal orders of muscular fibres; some of which pass obliquely from the base to the point, others cut the latter trans versely. From the exercise of these fibres two opposite motions result; one of dilatation, the other of contraction. The heart seems to execute these motions by turning on itself like a screw. Its point moves

towards or from the base, by rising or falling obliquely.

Two great vessels, viz, an artery and a vein, communicate with each ventricle. The artery,* which communicates with the right ventricle, conveys the blood to the lungs. The vein, which communicates with the same ventricle, forms the principal trunk of the veins, and carries back the blood from all parts to the heart. The artery: which goes into the left ventricle, is the chief trunk of the arteries, and that which conveys the blood to all parts. The veins which ends at the same ventricle, transmits to it the blood that has been conveyed from the lungs. The principal trunks of veins and arteries, are divided into several branches at a small distance from the heart. Some tend towards the upper extremities, others towards the inferior. The arteries and veins decrease in diameter, and are ramified more or less according to their distance from their origin. There is no part to which these do not distribute one or more ramifications. When they have arrived at the most remote parts, the arteries have an intercourse with the veins. The arteries are composed of several membranes, placed on each other. The veins have similar membranes, but more slender and weaker. The veins were not designed to exercise the same power as the arteries. These latter must necessarily, like the heart, and for the same end, dilate and contract themselves: they have therefore been provided with a very elastic membrane. The exercise of the veins should not be violent. At the root of the arteries, and in the inner part of the veins, are placed little sluices or valves, which by sinking and rising again, open and shut the canal. These valves are deposited in the veins, in a contrary sense from that for which they are in the arteries. We shall presently account for the cause of this difference.

20. After having been masticated and dissolved in the mouth and stomach, the aliment descends into the intestines, where it receives a new preparation by the mixture of two liquors, one of which is furnished by the liver, and is called the bile ; and the other by a species of glands situated under the stomach.

*The pulmonary artery.The venea cava. The grand artery, or the aorta.The pulminary vein The aliment is thus converted into a kind of grayish pulp, which has received the name of chyle. Being shifted from place to place by the vermicular or peristaltic motion of the intestines, and strongly pressed against their sides at the instant of their contraction, the chyle penetrates into extreme small vessels, which open themselves in the internal membrane of the intestinal canal. These vessels transmit the chyle to very small glands which are covered with a kind of membrane situated in the midst of the intestines, and round which they are in a manner rolled. After being filtrated in these glands, the chyle is received by other vessels, which convey it into a concavity placed along the spine, and which pours it into a vein situated under the left clavicle. There it enters into the blood, and loses the name of chyle From this vein the new blood passes into the upper branch of the principal trunk of veins, which carries it towards the heart. It passes into the right lobe, which opens at its approach, and by closing immediately, forces it into the right ventricle, which is dilated in order to receive it. The heart instantly contracts itself; the valves with which the ventricle is furnished, raising themselves to oppose the reflux of the blood into the lobe, it is compelled to pass the artery, which is appointed to carry it to the lungs. The valves, which are placed at the entrance of this artery, sink down; the artery dilates, and the blood advances into the cavity. The valves rise again, and prevent its return towards the heart. The artery contracting itself, the blood is impelled farther, and, by these alternate dilatations and contractions of the vessel, it is conveyed to the lungs, where it runs through every part of them. The ramifications of the trachea,

which are dispersed in the viscera, carry thither a fresh and elastic air, which, by acting on the lungs, dilates, winds them about, extends and opens them, and by that means facilitates the course of the blood into the smallest ramifications of the artery. Besides, being impregnated with this air, the blood becomes thereby attenuated, is warmed, and receives a more lively colour.After its arrival at the extremities of the artery, it passes into that of the pulmonary, vein, which conducts it to the left ventricle of the heart. This latter by contracting itself, pushes it into the aorta, which by continually dividing and subdividing itself, distributes this balsamic liquor to all the parts, in order to promote their growth, or support, and occasions different secretions.

*The pancrease and pancreatic juice.The primary lacteal reins. The mesentery and mesenteric glands. The secondary lacteal veins. The thoracic duct. ** The bronchia. See note page 69 of the first volume. The principal trunk of arteries

21. Such is the admirable mechanism of the circulation of the blood in men, and in those animals which we are best acquainted with. But. now greatly does this imperfect sketch fall short of the reality incapable are these outlines of expressing the beauties of this noble subject! And who can account for the manner by which the strength: of life is repaired and recruited Who can conceive the cause of that perpetual motion of the heart, which continues without intermission for the space of seventy, eighty, or a hundred years, which has lasted for ages in the first race of men, and which remains almost as long in some species of animals Rave we discovered the exact part where the artery is changed into a vein Have we disclosed the mystery of the secretion of those spirits, whose prodigious subtility and activity give them a near resemblance to light Can we even determine in what manner the grossest secretions are performed Do we under. stand the true mechanism of muscular motion Have we been able to find out the source of that great strength which often so far exceeds that of the heart All these dependencies on circulation are yet un revealed to us. The gloom of night still wraps these regions in dark obscurity, and you are earnestly desirous of chasing it away from before that sun which alone can dispel these shades. Will the dawn of that day ere long gild the horizon of the learned world Or is the time of its breaking forth upon us yet afar off But if we are not able to discover the whole, we may at least see enough of it to excite our admiration; and the sketch which I have just drawn of the circulation, is sufficient to enable us to conceive the highest ideas of the Sovereign mind, which has appointed the manner, duration, and end of it.

Far less magnificent in its plans, less skilful in the execution of them, hydraulics offer to us but faint images of this miracle; in those machines, by means of which water is raised above the mountains, in order to its being distributed into every quarter of a great city, and made to circulate and issue forth, under a hundred various forms, into those gardens which art and nature vie with each other in adorning and embellishing. The works of the Creator must be compared with the works of the Creator. Ever like Himself, He has impressed on all his productions a character of nobleness and excellence, which demonstrates the grandeur of their origin. From that immense mass of water that encompasses the great continents, there incessantly arises an ocean of vapours, which being rarefied by the combined action of the sun and air, spread themselves in the upper region of the atmosphere, where they remain suspended in equilibrio, being intermixed with the fluid in which they float, and gravitate with it. Collected afterward into clouds more or less dense, and borne on the wings of the winds, they fly across the celestial plans. which they adorn with their rich colours, and continually ‘variegated forms. Fixed at length on the mountain tops,

they pour upon them abundant rains, which being collected in the vast reservoirs, embosomed within them, furnish, by a happy circulation, a supply to fountains. rivers, lakes, and seas. Like veins and arteries, the rivers flow meandering, and branching‘the surface of the earth, they run through immense countries; water, fertilize, and unite them by a reciprocal commerce, and majestically rolling their waves toward the sea, plunge themselves into it, in order to be again exhaled in vapours, and re-enter afresh into the channels of this magnificent circulation.

22. Does the sap circulate in plants as the blood circulates in animals is this new mark of analogy between these two classes of organized bodies as real as it has appeared to be Small bladders full of air, which have been thought to be discovered within the leaves, have convinced us that they were the lungs of the plant. But there have not been discovered in plants, vessels analogous to veins and arteries. No organ has been seen in them capable of performing the functions of the heart. A tree which is planted a contrary way, with the roots at top and the branches in the ground, lives, grows, bears fruit; from its roots, branches shoot forth; from its branches, roots. The same is observed with respect to slips and layers. A young branch, or young fruit, after being grafted on a subject foreign to itself, incorporates with it, and derives from thence the same degree of growth it would have received from the plant whence it was detached. Experiments demonstrate that the motion of the sap depends entirely on the alternatives of heat arid cold, and the ‘vicissitudes of day and night. It is evident that the sap rises in the day from the roots to the leaves, and falls in the night from the leaves to the roots. In a word, the course of the sap nearly resembles that of the liquor contained in the tube of a thermometer. All is reduced to a simple counterpoise.

23. The nourishment of the more perfect animals requires to be more wrought than that of plants. Hence the necessity of the circulation of the blood. The preparations of the sap do not require such a punctual, regular, and constant motion; bare poisings suffice. Large animals eat but at particular times : a pressing sensation which induces them to take nourishment, does not continually act upon them. The different preparations their aliment should undergo, would be disturbed or interrupted, were a fresh supply to be received within them before the former was sufficiently digested.

Plants, on the contrary, are in a state of perpetual suction; they draw in nourishment continually, and in a very great quantity, in the day time by their roots, in the night by their leaves. There is a plant which receives and transpires, in the’ space of twenty-four hours, twenty times more than a man. But if plants differ so much from large animals by circulation, on the other hand some species of animals seem nearly to resemble plants by their want of this circulation. Not the least appearance of this motion is to be perceived in the polypus, the tape-worm, the pond-muscle, and divers other shell-fish.

24.One of the ancients defined a plant to be a rooted animal. He would undoubtedly have defined an animal to have been a wandering plant. The locomotive faculty is one of those characters which present themselves first, when we compare the vegetable kingdom with the animal. We see plants that are constantly fixed on the earth Being incapable of seeking their nourishment, it is ordained that this nourishment shall seek them. The greatest part of animals, on the contrary, are subjected to the care of providing their own substinence Nature has not always deposited near them such nourishment as necessary for their support. She has thought proper to oblige them to procure it for themselves, often with much labour. And the different methods by which she has instructed each

species to obtain this end, much diversify the scene of our world.

Whilst the ploughman opens the earth, to entrust with it the seeds necessary to support him, the mole and the mole-cricket are clearly for themselves different route, in the same, to search for the food allot ted to them. The huntsman pursues his prey with an obstinate resolution: triumphing in his swiftness and strength. At other times preferring craft he becomes master of it by laying snares for it. The tyger rushes on the fawn sporting in the meadow. The cat watches motionless and silent, till the young mouse issues forth from its retreat, that she may dart upon it in a moment. Some species of animals,. resembling mankind by their prudence, lay up provisions against a time of scarcity; build themselves magazines, in which are observed' such just proportions, as to give us cause to doubt whether it was the workmanship of a brute, were we not convinced that this brute itself is the work of Sovereign Reason.

25. How great is the distance in this respect from the beaver and bee, to the gall or cochineal insect, the oyster, the sea-nettle, and several other kinds of insects and shell-fish The gall-insect, being confounded, by his immobility and form, with the tree on which he lives, contents himself with extracting its juice. Carried by the wave to the sea-shore, the oyster remains fixed there, and all its motions consist in opening and closing its shell. The sea-nettle,* and all the different polypuses with pipes, being continually fixed to the same place, open amid shut like a flower; extend and contract themselves like a sensitive plant; stretch out arms, by means of which they seize insects. This is their principal character, and the least equivocal character of their animality.

*This is what is called the vegetable sea-nettle. There is a fish so called which swims by a particular contraction of its parts.

Thus it appears that the locomotive faculty is not more proper 'for distinguishing the vegetable from the animal, and those other character which we have before treated of. in the mean time, what canmore distinct in appearance than a plant is from an animal Or 'what more easy to characterize in the sight of the major part of mankind But when once we are convinced that 'every thing in nature is shadowed over, we are not surprised at the difficulties we meet with in our attempts to distinguish beings. We expect to see the species enter again into each other: and confine ourselves to the smallest latitude, or to that which is attended with the least uncertainty. In this principle we will conclude the parallel: let us see whether feeling, and the manner by which animals and vegetables are nourished, will furnish us with any thing more characteristical.

26. If there be any faculty which seems peculiar to the animal, it is certainly that of feeling. Being united to an organized substance, by ties which perhaps are known to God only, this soul composes with this substance a mixed being, a being which partakes of the nature of bodies, and of that of spirits. As a portion of matter, it is a machine which is admirable in its structure, and on which corporeal objects act mechanically. As a spiritual substance, it is affected at the presence of spiritual objects in a manner which does not seem to have any relation with that by which material substances act on each other. From the expression of external objects on the machine there results a certain motion in the machine. From this motion there follows a certain sensation in the soul, which is succeeded by the reaction of the spiritual substance on the corporeal; a reaction which manifests feeling from without, and which is the expression or sign of it. The various sensations in the animal may be reduced to these two general classes, pleasure and pain, separated from each other by degrees which are frequently insensible, and issuing from the same

origin. The expression of pleasure and pain is not alike in all animals; because the organs, by means whereof the soul manifests her sentiments, are not the same in all.

There are species in which feeling is manifested by a greater number of signs: more varied, more expressive. What expression, for instance, is there in the air, the motions, and the various attitudes of an ape, a horse, a dog, a cat There is not much less expression in birds than in quadrupeds. Fishes do not express themselves with the same clearness and energy; they form a dumb people, amongst whom the language by signs is little practised: but the extreme vivacity of their motions seems in part to compensate for their sterility of expression. Reptiles, shell-fish, and insects, which are still at a greater distance from us than fishes, express to us their feelings in a more obscure manner: but which, notwithstanding, we can conceive to certain degree, and often acknowledge to be very expressive. On the contrary, we do not discover in the plant any Sign of feeling All in that seems to be purely mechanical. Its life appears to be less a life than a simple duration. We cultivate a plant or we destroy it, without experiencing any thing similar to what we meet with when we cherish an animal, or put it to death. We see the p1 shoot forth, grow, flourish and bud, as we perceive the hand of a clock to have passed over the points of the dial.

These considerations lead us to consider feeling as a character proper for distinguishing the vegetable from the animal.

27. Since then the faculty of feeling furnishes us but with a doubtful character for distinguishing the vegetable from the mal, which is that we should have recourse to with this view I think we have exhausted them all : we have at least treated of them all in a cursory manner. But we have not examined them all under their various aspects. There is one of them, which being considered in a certain point of view, may perhaps procure us what we have in vain searched for in the others.

We may now consider the position of those organs by which plants and animals receive their nourishment. These organs in plants are the roots and leaves. Both of them are furnished with pores, by means of which they pump in the nutricious juice. These pores terminate at small vessels, which transmit the juice into the inner part: or, rather, these pores are only the extremity of these vessels.

Animals have organs which are entirely analogous to roots and leaves ; I mean lacteal veins, or vessels which answer the same purpose. These veins open themselves in the intestines, and pump the chyle into them, which they convey into the channels of circulation. An animal is then an organized body, which is nourished by roots placed within him. A plant is an organized body, which receives its nourishment by means of roots placed on its outside.

Yet an animal which is nourished by pores distributed on its outside, renders this character ambiguous. The tape-worm seems such an animal. It forms in the intestines a great number of plaits: and sometimes entirely fills the capacity of this canal. Each of the rings that compose it, and whose length is rarely more than one or two lines is pierced with a small, round aperture, by which one may see the chyle issue, which the worm is full of, and which constitutes its principal nourishment. If this aperture is a kind of sucker, by the help of which the insect pumps the chyle that surrounds it, this method of nourishing itself varies but little from that of plants. But without seeking very far for examples of animals that are nourished like plants, this is the case of all animals, whether oviparous or viviparous, whilst they are enclosed in the egg, or in the belly of

their mother. The umbilical vessels may be considered in the egg or in the matrix, as roots which imbibe the nourishment. It is the same with respect to insects that multiply by shoots. Whilst the young one still adheres to its mother, it is nourished in a manner little different from that which is peculiar to branches. Animal grafts nearly resemble vegetable in this particular.

Lastly, the skin of the human body imbibes, like the leaves of plants the vapours with which the air abounds: and although men draw in much less nourishment by this means than vegetables, it is nevertheless true that their skin and leaves have, in regard to this circumstance, a great affinity to each other. Perhaps we may be able some time or other, to discover animals which are nourished by their skin only, as certain plants are by their leaves.

28. Do we then in vain seek for a peculiar character, whereby we ‘may distinguish the vegetable from the animal I perceive a new property which will perhaps furnish us with what we seek for. A muscular fibre contracts of itself on the touch of all bodies, whether solid or liquid. This property is known by the name of irritability. It has nothing in it common to sensibility. The parts which are most sensible are not irritable, and the parts which are most irritable, are not sensible. Neither ought we to confound irritability with elasticity. A dry fibre is very elastic, and not at all irritable. Animals purely gelatinous are not elastic, and are notwithing very irritable, in short, the fibres of old men, though much more elastic than those of infants, are much less irritable.

We have seen that the heart is a real muscle. If we extract it from the breast it will continue to move till it has lost its natural heat. The heart of a viper or tortoise beats strongly for the space of twenty or thirty hours after the death of the animal. Water or air, when introduced into the ventricle, are sufficient to restore to the heart the motion it has lost. The peristaltic motion of the intestines is likewise owing to their irritability. But the fbllowing is what we should not have guessed at. If they are plucked hastily from the lower belly, and cut into pieces, all these pieces will crawl like worms, and contract themselves on the slightest touch. So that not only every muscle, but also every fragment of a muscle, and even every muscular fibre, contract themselves more or less on being touched by any body whatsoever, especially if that body be of a stimulating nature. And as the fibre contracts so it likewise recovers of itself, and this alternate exercise lasts for a time proportionable to the degree of irritability.

It is evident from all the experiments that the vital parts are the most irritable. The heart is the most irritable of all, and next to that, the intestines and diaphragm. The nature of irritability is unknown: we only judge of it its effects. It probably resides in the elastic fluid which is interspersed between the lamellae of the fibre. The nerves are not irritable; but if a nerve be pricked, the muscle at which it terminates will contract itself. The nerves may then give motion to muscles; but they do not communicate an irritability to them which they are not possessed of themselves; they only put it into action. and thus they are ministers of the affections of the soul.

Irritability then seems to be what constitutes the vital Power is the animal ; and this prosperity has not been perceived in the vegetable. Is it not then the distinguishing character we seek for

Chapter 11 - Of the Industry of Animals

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1. Hitherto we have scarcely considered animals in any other light, than with respect to the organization, and the immediate and general consequences of it. We will now contemplate their industry, which is still more interesting to us.

Some animals seem reducible to feeling only. Others have all our senses, and raise almost to understanding. The distance from the polypus to the ape appears enormous.

Imagination and memory are observable in divers species; imagination in their dreams; memory in the recollection of such things as have affected them. Places, persons, animate and inanimate objects are traced out in their brain, and they act agreeably to these representations. The degree of knowledge in each species answers to the place it occupies in the general plan. The sphere of his knowledge extends to all cases which the animal may naturally meet. And if the animal happens to be drawn from his natural circle, and nevertheless is not entirely removed out of it, we may conclude that this new situation has a relation to one of the cases to which the sphere of his knowledge extends. The way whereby animals vary their proceedings as necessity re quires, furnishes one of the strongest arguments against the opinion which transforms them into mere machines. The philosopher who attributes to them a soul, founds his judgment on the analogy of their organs with ours, and of their actions with several of ours. Those who make the soul material, forget that even feeling is incompatible with the properties of matter. The greater the number of cases is to which the knowledge of an animal extends, the higher is this animal elevated in the scale. The preservation of life, the propagation of the species, and the care of their young, are the three principal branches of the know. ledge of animals: but all are not alike to be admired in these respects. The oyster knows only how to open and close its shell. The spider spreads a net for his prey; waits like a huntsman, till some insect falls into the snare ; hardly has he touched it before be darts upon it. Is he armed, or too nimble He fastens the lines to him with wonderful skill, and thus disables it either from flying or defending itself.

Divers species of animals live from day to day, without taking any thought for the succeeding day. Others seem endowed with a kind of foresight, construct magazines with abundance of art, which they fill with various kinds of provisions: such are the bee and the beaver.

Among animals that live by prey, some, like the eagle and the lion, attack with open force. Others, as the hawk and the fox, join craft to strength. Some save their lives by flight; others by hiding themselves under the earth or water; while others still have recourse to divers stratagems to facilitate their flight, and evade the pursuit of their enemy.

Those philosophers, who take a great deal of pains to define instinct, are not aware, that in order to do it, they should spend some time in the head of an animal, without becoming the animal itself. To say in general, that instinct is the result of the impression of certain objects on the machine, of the machine on the soul, and of the soul on the machine ; is to substitute terms that are a little less

obscure, instead of a very obscure term: but the idea does not issue from the thick darkness that covers it. We well know what is not instinct, but are utterly ignorant what it is. It is not understanding or reason. The brute has neither our notions., nor our mean ideas; because it has not our signs.

2. At the same time that nature has taught divers animals the method of attacking and pursuing their prey, she has instructed them in that of self-defence or escaping. If we were conversant in the books of nature, we should there see, without doubt, that the profit always makes amends for the loss. A register of the births and deaths of some species puts this truth beyond all controversy. The species which multiply most, have the greatest number of enemies. Caterpillars and vine-fretters are attacked as much within as without, by I know not how many insects, that are always bent on destroying the individuals, without being able to effect the destruction of the species. Many species seek their living or retreat in the inner part of the earth, or in that of plants and animals. Others build themselves nests or shells, with amazing art, where they pass their time is weakness and inactivity.

Some that are more skilful, can, like us, make themselves clothes and even procure matter for their nourishment. They strip our clothes and furs of their hairs, and make a kind of stuff of it, where with they clothe themselves. The form of their dress is very simple, but very commodious. It is a sort of muff or case, which they can lengthen or widen as they find occasion. They lengthen it by adding to each end new layers of silk and hair, and widen it as we do a glove, by cutting it in the middle according to the length of it, and by engrafting a piece. You may imagine that I am speaking of house-moths : field-moths, which clothe themselves with leaves, surpass them in industry.

Several kinds of fishes and birds change, at a stated time their dwelling places. We have seen numerous shoals of herrings and codfish, and flocks of geese, quails, and crows resembling thick clouds, that sometimes darken the air. By such periodical emigrations the. species are preserved, and in their long pilgrimages, nature is their pilot and provider.

3. The grasshopper, lizard, tortoise, and crocodile, furnish examples of animals that scarce take any care of their eggs, and are almost wholly unmindful of the young that are hatched from them. They lay them in the earth or sand, and leave the sun to communicate the warmth necessary for them. Shell-fish practice the same method: some spawn in the water; others between stones, or in the sand. The instinct of the different species consists in depositing them in places where the young may find proper nourishment at their birth. The mothers commit no mistake with respect to that. The butterfly of the cabbage-caterpillar never lays her eggs on meat, nor the flesh-fly on the cabbage. The gnat, that flutters in the air, was first an inhabitant of the water. For this reason, her eggs are always deposited in the water. The mass formed by them resembles a little vessel which the insect sets afloat. Each egg is in the form of a keel. All the keels are vertical, arid are disposed back to back. The gnat lays but one at a time. We cannot devise how she can cause the first egg or keel to remain in the water. Her method is nevertheless very simple, but much more ingenious. She stretches out her long legs behind her, crosses them, and by thus forming an angle of them, receives the first egg, and holds it at pleasure. A second egg is soon placed next the first; then a third, fourth, &c. The base of the pyramid thus widens by little and little, and at length is capable of sustaining itself.

Some species glue their eggs with great symmetry and propriety round the branches or small shoots of trees, like rings or circles. One would be apt to say, that so the skilful hand had been diverting itself in fitting pearl bracelets on the sprigs. A caterpillar, which from the distribution of its colours, is called livery, transforms itself into a butterfly, that disposes her eggs in this manner, and forms these pretty bracelets of them.

Other butterflies do still more: they strip themselves of their hair, and make with it a kind of nest for their eggs, where they lie soft and warm. Such in particular, is the industrious workmanship of the butterfly, proceeding from that called the common caterpillar, because it is in fact most common in these countries.

4. Certain species are so attached to their eggs, that they carry them about with them every where. The wolf-spider encloses hers in a little silk purse, which she bears on her hind part. Does any one destroy it, or take it from her Her natural vivacity and agility abandon her: she seems to fall into a kind of languor. Has she the happiness to recover the precious trust She instantly seizes it, carries it away, and betakes herself to flight. As soon as the little spiders are hatched, they collect and arrange themselves skilfully on the back of their darn, who continues for some time to bestow her attention on them, and to transport them with her every where she goes.

Another spider lodges her eggs in a little silk purse, which she wraps up in a leaf. She fixes herself on this purse, and sits on her eggs with amazing assiduity. Another, to conclude, encloses hers in two or three little silk balls, which she suspends by threads ; but has the precaution to hang before, at a small distance, a little bunch of dry leaves, to conceal them from the inspection of the curious.

5. Divers species of solitary flies are not less to be admired, as well for their foresight in amassing provisions for their little ones, as for the art displayed by them in the nests they prepare for their recep. tion. The mason-bee, so called, because, like us, she understands the art of building, performs such works in masonry, as one would imagine must greatly surpass the strength of a fly. With sand, collected grain by grain, and glued together with a kind of cement much preferable to ours, she erects a house for her family; a very simple one indeed, but extremely solid and commodious. It is divided within into several chambers or cabins, on the back of each other, without any communication between them. One general foldage, a wall of enclosure, comprehends them all, and leaves no opening without. This wall must be broke before the apartments can be seen, and it is found to be as hard as a stone. These nests are very common on the fronts of houses : they there resemble little oval hillocks, of a different grey from that of the stone. The fly that is the architect of these buildings, deposits an egg in each chamber, and shuts up in it at the same time a stock of wax or paste, which is the nourishment appropriated to her young.

Another fly which may be called the carpenter-bee, because she works in wood, likewise builds apartments for her family, but in a different taste from that of the mason. Sometimes she distributes them into stages; sometimes disposes them in a row. Ceilings, or partitions, artfully made, separate all these stages or chambers, and there is an egg deposited in each of them, with the quantity of paste necessary for the young.

6. These various kinds of work require in general less skill and genius than labour and patience. There is a very different degree of art and sagacity displayed in the nest constructed by another fly

with single pieces of leaves only. This nest is a real prodigy of industry. When. it is taken to pieces, and narrowly examined in all its parts, one can. not conceive how a fly should be able to cut them out, turn, and put them together with so much propriety and exactness. When viewed. on the outside,. this nest very much resembles a tooth pick case. The. inside is divided into several little cells, in the form of a thimble, set in one another as thimbles are in a tradesman's shop. Every thimble consists of several pieces, which are separately cut from one leaf, and whose form, circumference and proportions tally with the place each is intended to occupy. The same method is used with respect to the pieces that form the case or common cover. In a word, there is so much exactness, symmetry, uniformity, and skill in this little masterpiece, that we should not believe it to be the work of a fly, did we not know at what school she learned the art of constructing it. We may naturally conjecture that each thimble is a lodging for; a little one; but we could not have imagined that the paste which the mother provides for it is almost liquid, and that the little cell, which is entirely composed of small pieces of leaves, is notwithstanding a vessel so well closed up, that this paste never spills, even when the vessel is stooped.

7. Many brutes act in concert with each other. A drove of oxen is grazing in a meadow: a wolf appears: they immediately form into a battalion, and present their horns to the enemy. This warlike disposition disconcerts him, and obliges him to retire. In winter, hinds and young stags assemble in herds, in the more numerous companies as the season happens to prove severe. They warm each other with their breath. In the spring they separate, the hinds concealing themselves in order to bring forth. The young harts remain together, love to walk in company, and are only parted by necessity.

Sheep that are exposed to the sultry heat of the dog-days, in an open plain, keep near each other, so that their heads touch; they hold them inclined towards the earth, and snuff up the fresh air which comes from beneath them.

Wild ducks that are accustomed to change their climate, range themselves in their flight in the form of a wedge, or an inverted V, that they may cleave the air with the greater ease. The duck at the extreme point leads the flight, and cleaves the air first of all. After a certain time he is relieved by another, the second in his turn by a third, &c. In this manner each bears a share in the laborious part of this office

8. Animals to whom the company of their own kind is useful, have been rendered fit for this commerce. And if the Author of nature bad man in view with respect to this particular, as we may without pride suppose, the means will be found to correspond perfectly well with the end. In effect, how many embarrassments and inconveniences would have accompanied the divers services we deduce from domestic animals, if individuals of the same species had not power to cohabit together! The spirit of society is not altogether limited to individuals of the same species, but extends likewise in a certain degree' to those of different species, and from thence man also derives some advantage. The custom of seeing each other, of eating their meals in common, of reposing under the same roof, confirms the natural disposition of domestic animals to live in society. The connexions which result from it, become so much the stronger, as they begin earlier or nearer to their birth. Thus animals that are not appointed to live together, may, notwithstanding form a sort of society: the natural inclination each of them has to live with those of a like kind, is susceptible of modification or extension.

Every individual knows his like ; those of the same society likewise know them. It is observable, that if strange fowls are brought into a poultry yard, those of the place will persecute them till cohabitation has made them members of the society. The outside of the body exhibits divers characters, by means of which individuals of the same society may know each other, and distinguish strange individuals. But among these physical characters, there may be some mixed ones, or such as belong as much to the soul as to the body, which the animals of the class we are treating of, are capable of seizing; such are the air, posture, gait. The individuals of that species which are not yet become familiar in their new habitation, seem fearful or embarrassed ; this fear or embarrassment detects them, and excites or encourages others to attack them. That kind of society in which domestic animals live, gives room for a remarkable observation ; the young lamb distinguishes her mother from amongst three or four hundred sheep, although there does not appear to be any sensible difference betwixt them.

9. Nothing is more wonderful than those legions of flying creatures. that at a stipulated time pass from one to other very remote countries. What instinct assembles them What compass directs them What chart points out their ‘way We presently conceive that the change of season, and the want of suitable nourishment, advertise these different species of birds to shift their abode. But whence did they learn that they should meet with in other regions a climate and aliment proper for them In order to be able to answer these questions, and all such as may be asked on this interesting subject, we should care fully examine every circumstance that attends the marches of them, birds. The degree of coki or heat that accelerates or retards them; deserves to be particularly attended to: for there is no room to doubt that they are most of all influenced by this. There is perhaps a secret relation between the temperature which suits with certain species, and that which is necessary for the production of food that nourishes them. But we have not carried our inquiries deep enough into these different species of birds and fishes of passage.

10. Among the societies of brutes, improperly so called, some depend on chance, or on the agency of men, if not altogether, at least in part. It is not so with respect to societies, properly so called They do not owe their origin to any human act, but solely to nature, The members that compose them are not only united by common necessities, and that for a short time; but they are so by a much stronger tie, which subsists to the death of the animal, or, at least, during a considerable part of its life ; I mean, the natural preservation of the individual, or that of its family. Both the one and the other are necessarily attached to the state of society. It is for this great end that these different species of social animals have been. instructed to labour in common on works so worthy of admiration.

Societies, properly so called, may be divided into two classes ; the first comprehends those whose principal end is limited to the preservation of individuals; the second, those whose scope is the preservation of individuals and education of their young.

Several species of caterpillars, and some species of worms, belong to the former of these two classes; ants, wasps, bees, beavers, to the second. The first class will have under it two principal sorts ; one of which will comprehend temporary societies ; the other, societies for life.

11. A butterfly deposits her eggs about the middle of summer, on the leaf of a plum-tree; the number of these eggs is three or four hundred. After some days, there issues from each of them a very small caterpillar. They are so far from dispersing themselves on the adjoining leaves, that

they all continue together on that whereon they first received their being: the same spirit of society unites them. They apply themselves immediately in concert in the spinning of a web, which at first is very thin, but they afterwards make it stronger, by gradually adding new threads to it. This web is a real tent spread upon the leaf under which the young caterpillars shelter themselves. As they increase in bulk, they extend their lodging by fresh layers of leaves and silk. The spaces contained between these layers are apartments, all of which communicate by doors made on purpose. In this nest they pass the winter, placed near each other, without motion, till the returning spring enlivens them, and invites them to bronze on the sprouting leaves. Lastly, towards the month of May, the society is dissolved; every caterpillar separates from his companion, and spends the remainder of his life in solitude. ‘Being then become stronger, a state of society is no longer necessary for them.

12.The caterpillars that live on the oak, and whose societies are much more numerous than those of the common, are very singular in their proceedings. They set out from their nest at sunset, and march in procession, under the conduct of a chief, whose motions they follow. The ranks are at first composed only of one caterpillar, afterward of two, three, four, and sometimes more. The chief has nothing in him that may distinguish him from the rest, but by being the first, and that he is not constantly, because every other caterpillar may in his turn occupy the same place. After having taken their repast on the leaves around them, they return to their nest in the same order; and this continues during the whole life of the caterpillar. When they have arrived to their full growth, each forms for himself a cone, where it is transformed into a chrysalis, and afterward assumes the form of a butterfly. These metamorphoses cause a new kind of life to succeed to the state of society, which is very. different from the primitive one. This is an example of societies for life, whose principal end is the preservation of individuals.

13.There are several kinds of caterpillars that are true republicans, and whose discipline, manners and genius, diversify them as much as those of different people. Some of them, like savages, make themselves hammocks, in which they take their meals, and even pass their whole lives. Others live like the Arabs and Tartars, in tents, which they erect in the meadows; and when they have consumed all the herbs that grew about them, they go away and pitch their camp elsewhere. The nests which the republican caterpillars make for themselves are perfect retreats; they are screened in them from the injuries of the air, and are all closely shut up in times of inaction or idleness. But they go out at certain hours to seek their nourishment. They feed on the leaves which surround them, which they consume one after another. They often go to a great distance from their dwelling, and by different turnings. However, they can always find it again, when they have occasion. Nature has provided them with a method for regaining their lodging, which answers exactly to that used by Theseus for fetching Ariadne out of the labyrinth. We pave our ways; our caterpillars line theirs with tapestry. They flever but on silk carpets. All the paths that lead to their nest are covered with silk threads. These threads form tracks of a glossy white which are at least two or three lines in width. By pursuing the tracts in a row, they never lose their way, how intricate soever the turnings and windings of their passage may be. By putting a on the track, we should intersect the path, and throw the caterpillar into the greatest perplexity. They stop on a sudden at this place and express all the signs of fear and distrust. Their march is pended, till some caterpillar, more bold than the rest, crosses over the spoiled path. The thread she spreads in crossing serves bridge for the next to pass over. This in passing spreads another thread; a third another, and thus the way is soon repaired

Yet there is a great difference between the method of the republican caterpillars, and that of Theseus. They do not spread a carpet over their paths, to prevent their missing their way; but they do not miss their way, because they spread such a carpet. They spin continually, because they have always occasion to evacuate the silky matter, which their nourishment produces again, and which is enclosed in their intestines. By satisfying this want, they are assured of being in the right path, without attending to it. The construction of the nest is likewise connected with this want. Its architecture is adapted to the form of the animal, to the structure and exercise of his organs, and to his particular circumstances.

14. Ants seek their provisions and aliment at a great distance from their abode. Various paths, which are often very winding and intricate, terminate at their nest. The ants pass over them in rows, without ever missing their way, any more than the republican caterpillars. Like the latter, they leave tracks wherever they pass. These are not discernable to the eye ; they are much more sensible to the smell; and it is well known that ants have a very penetrating one. However, if we draw a finger several times backwards and forwards along the wall by which the ants pass and repass up and down in rows, they will be stopped on a sudden in their march, and it will afford some amusement to observe the perplexity they are in. It will happen in the same manner with regard to the processions of these ants, as has been before related concerning those of the caterpillars.

15.The sight of a bee-hive is certainly one of the finest that can offer itself to our eyes. There appears in it an astonishing air of grandeur. One can never be weary of contemplating these workshops, where thousands of labourers are constantly employed in different works. We are struck in a particular manner with the geometrical exactness of their works; as we likewise are at the sight of their magazines. which are replenished with every thing necessary for the support of the society during the rigorous season. We like. wise stop with pleasure to behold the young ones in their cradles, and to observe the tender care of their nursing mothers towards them. But what chiefly attracts the attention, is the queen: the slowness I had almost said gravity, of her march, her stature, which is a more advantageous one than that of the other bees, and, above all, the various homage paid her by the rest. We can scarcely believe what our eyes are witnesses of, in the regard and assiduities of the neuters for this beloved queen. But our amazement is greatly heightened when we see these laborious, active insects, entirely cease from their labour, and suffer themselves to perish, as soon as they are deprived of their sovereign. By what secret engagement, by what law superior to that whereby each individual provides for its own preservation, are the bees attached to their queen in such a degree, as absolutely to neglect the care of their own lives, when they happen to be separated from her This law seems to be nothing more than the grand principle of the preservation of the species: the neuters do not engender; but they know that the queen enjoys that faculty: they construct those cells, whose proportions we so much admire, for the reception of the eggs she is ready to lay. Nature has instructed them as much with regard to the young that is to be hatched from them, as she has the mothers of other animals in favour of their offspring.

16.Of all animals that live in society, none approach nearer to human understanding than beavers. We are at a loss to determine what is most worthy of admiration in their labours, whether the grandeur and solidity of the undertaking, or prodigious art, fine views, and general design, to excellently displayed throughout every part of their execution. A society of beavers seem to be an

academy of engineers, that proceed on rational plans, which they rectify or modify as they judge necessary, pursuing them with as much constancy as precision; all are animated by the same spirit, and unite their will and strength for the promoting one common end, which is always the general good of the society. In a word, we must be witnesses of their performances, before we can judge them capable of them. A traveller that is ignorant of them, and happens to meet with their habitations, will think he is among a nation of very industrious savages. The mole or bank which they raise, is a work of immense labour, and it is inconceivable how brutes are able to project, begin, and complete it. Represent to yourself a river of fourscore or a hundred feet in width. The first business is, to break the force of the current. The beavers then throw up a bank or causeway eighty or a hundred feet in length. by ten or twelve feet at its base. Nothing is more certain than this, nor less likely: and when we have repeatedly seen it, we are still willing to renew our inspection of it, in order to enforce our belief. The most considerable towns of the beavers consist of twenty or twenty-five lodgments, though such are but rare. The most common have only ten or twelve. Each republic has its peculiar district, and admits of no accidental guests. When any great inundations damage the edifices of the beavers, all the societies, without exception, unite together for making the necessary repairs. If hunters declare a cruel war against them, and entirely destroy their banks and cottages, they disperse themselves about the country, betake themselves to a solitary life, dig burrows or trenches under ground, and never show any marks of that industry we have been admiring.

17. Beavers seem to be formed with a view to confound our reasonings. Their associating themselves into great bodies, for working in concert on their immense works; their separating into little families, or particular societies, charged with the construction of the huts; the nature of these works, their extent, solidity, propriety, and appropriation so conducive to one general end, comprehending such a number of subordinations; in a word, their almost perfect resemblance with works erected by men with the same intent; all concur to give the labour of the beavers an undoubted superiority over that of the bees. In fact, to fell trees chosen on purpose, to lop them and cut off their projections, to make great cross pieces of timber of them, disposing them in their proper places; to cut smaller trees like stakes, plant several rows of these stakes in a river, and interlace them with branches of trees, in order to strengthen and connect them together; to make mortar, and with it solidly to compact the inside of the pile: and to all this add the form, proportions and solidity of a• great bank; to form sluices thereon, and open and shut them according to the water’s elevation or abatement; to build behind the bank little houses, one or more stories high, founded on an entire pile-work; to build them solidly without, and incrust or cement them within by a layer of plaster, applied with equal exactness and propriety; to cover the flooring with a verdant tapestry; to contrive lights and outlets in the walls for different purposes; to erect magazines and supply them with provisions; to repair with diligence whatever breaches may happen to the public works, and reunite themselves into one grand body for the effecting in common these reparations: are astonishing marks of industry, which seem to imply in the beavers a ray of that light, which raises man so far above the rest of the animal creation.

Chapter 12 - Continuation of the Industry of Animals

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1. We shall, in the next place, treat of the proceedings of solitary animals. If they do not affect that extraordinary air of reflection and prudence, that brightness of genius, and that appearance of policy and legislation which we admire in sociable animals, they nevertheless attract our regard, either by their simplicity and singularity, or their diversity and appropriation to one common end, for the attaining of which they use the ingenious and natural means. After having contemplated the government,, manners, and labours of a republican community, we may still find some pleasure in considering the life and occupations of a solitary one, thus passing from the monuments of Rome to the cottage of a Robinson. Those works that are performed by the sociable animals, and which astonish us as much by their size as by the beauty of their disposition, result from the concurrence of a number of individuals- They all pass through various hands: some sketch them, others bring them to q greater perfection, and a third sort finish them. The works of solitary animals spring from one bead only; and the same hand that begins them, continues, finishes and repairs them. Each individual has his particular talent and degree of skill, whereby he provides for his own subsistence, and furnishes himself with all necessaries.

We will here confine ourselves to the proceedings relative to the metamorphosis: this is an affair of great importance for one of our hermits to prepare himself for, the most interesting to him of any during his whole life. Caterpillars alone exhibit to us the examples of almost all the proceedings which nature has taught to insects of this kind. We will limit our examinations to this class in particular.

2. There are some caterpillars whose bodies are supported by a prop, and nature has taught them the method of effecting this. They wind a girdle round their body, composed of a number of silk threads collected together, whose ends are fixed to the prop that sustains them. By this means they fasten their hind legs in a little heap of silk. It is easy to imagine after this, that the chrysalis must be tied and grappled as the caterpillar was. The girdle is loose, and leaves the chrysalis sufficient room to perform its little operations.

3. Other caterpillars form cones. Some of these give their cone a more exquisite form, so as to resemble that of an inverted boat. The cone of a silk-worm is made, f we may be allowed the expression, of a single piece. The cones made boat-wise consist of two principal parts, shaped like shells, and joined together with great skill and pin priety. Each shell is worked separately, and formed of an almost infinite number of very minute silk rings. On the fore part of the cone, which represents the hind part of the boat, is a ledge that juts out a little, in which we may perceive a very narrow crevice, which denotes the aperture contrived for the exit of the butterfly. Bt means of that the two shells may part asunder, and leave room for the butterfly to pass through them. They are constructed and put together with so much art, that they are of the nature of a spring; and the cone from whence the butterfly has lately issued, appears as close as that which it still inhabits. By this ingenious artifice, the butterfly is always free, and the chrysalis in safety. We shall hereafter come

to treat of proceedings which are analogous to these, but more singular.

4. Our spinners have not all an equal provision, yet all seem to, endeavour at concealing themselves from sight. Such as are not rich enough to make themselves a good lodgment of silk, supply the want of it by different matters of a coarser or finer texture, which they are sufficiently skilful to cause to contribute towards the construction of the lodge. Some content themselves with giving it a covering of. leaves, which they connect together without any art. Others do not confine themselves to the amassing these leaves, and disposing them indiscriminately: but range them with a kind of regularity. Others think proper to powder the whole of their cone with a matter they yield from behind them, and which they cause to penetrate betwixt the thread. Others strip themselves of their hairs, and form a mass of a mixture of silk and hairs. Others, after having stripped themselves, plant their long hairs about them, and make of them a sort of cradle-fence. Others add a greasy matter, which they procure from their inside, to the silk and hairs ; with this they stop up the rings of the weft, and it serves as a varnish for them. Others thrust themselves into sand or small gravel, and there construct for themselves cones of sand, whose grains are connected with the silk. Others, lastly, which have no silk, pierce the earth, make a cavity in it like a cone, and smear the sides of it with a kind of glue or paste.

Another species, which is far more industrious than the former, perform a work which we cannot too much admire. You have lately seen described those cones which resemble an inverted boat; this is likewise the form that this species give to their cone; but they do not make it entirely of silk. They strip off little pieces of bark with their teeth, of a rectangular figure, nearly even and alike, and dispose them with all skill and propriety; with these they compose the principal parts of the cone. These great parts are likewise formed of a considerable quantity of very small inlaid work, placed end to end, and joined together with silk. In a word, we are apt to fancy that we are looking at an inlaid floor, or a piece of inlaid work.

5. The most solitary of all insects are such as live in the inside of fruits. Each fruit lodges only one caterpillar or worm. We are ignorant of the cause of this remarkable fact. We only know, that a curious observer, having attempted to cause caterpillars of this species to live together they furiously engaged each other as often as they met It is then incontestibly true, that the disposition of these cater. pillars is anti-sociable. Several have metamorphosed themselves in the very fruit that has served them for a retreat and for provision; they dig cavities in it, which they line with silk, or in which they spin their cones. Others, which are the greater part of them, quit the fruit, and metamorphose themselves in the earth.

6.Those insects that roll up or fold the leaves of a great number of plants, are also perfect hermit& This proceeding is common to many caterpillars. They thus procure for themselves little cells, which are convenient lodgings for them, in which they are always sure to find nourishment; for they eat the walls of the cell; but they are always very careful never to touch that part which is destined to cover them. The different methods in which these caterpillars lodge themselves, give room for distinguishing them into tiers, folders, and rollers. The art of the tiers is in general the most simple. It consists in joining several leaves together with silk threads, in order to form them into one entire parcel, in the centre of which is the lodge of the little hermit.

The procedure of the folders supposes more refined operations. They fold the leaves either in the whole, or in part. In the whole, when the portion folded is turned back flat upon another part of the

leaf: and in part, when they only simply bend the leaf more or less. But the labour of the rollers is most of all to be admired. They live in a kind of roll, whose dimensions, form, and position vary in different species. Some give it a cylindrical figure; others, the form of a cone, which is likewise as well made as those the grocers use. The leaf is always rolled spirally, or as wafers are. The roll or cone is commonly laid on the leaf; but sometimes, which is very remarkable, it is fixed on it like a nine-pin. Does my reader imagine that mechanism presides over the construction of these various works Does he conceive in what manner an insect, that has no claws, is able to roll up a leaf, and to keep it so We know in general, that caterpillars spin: and can in some measure discover, it is by the assistance of their threads, that our skilful rollers cause the leaves to take the form of a cylindrical or conical tube. We see in effect, parcels of threads distributed from one distance to another, which hold the roller confined to the leaf But how can these threads, which seem only to perform the office of small cables, he capable of rolling up the leaf This we imagine ourselves able to guess at, but without effect. We suppose, that by fastening threads to the edge of the leaf, and drawing those threads towards her caterpillar forces the edge to rise and turn itself; which is by no means the case. The use the industrious insect makes of its strength consists of a more refined mechanism. He fixes a number of threads to the border of the leaf, but does not draw it to him. By means of them he bends the other extremity to the surface of the leaf The threads of one and the same parcel are nearly parallel, and compose a little ribband. By the side of this ribband the insect spins a second. which passes over and crosses the former. This then is the secret of its mechanism. In passing over the first ribband in order to extend the second, it bears on the first with the whole weight of its body this pressure, which tends to force down the ribband, obliges the edge of the leaf, to which it is fastened, to rise. The second ribband, Which is at the same time struck on the flat part of the leaf, preserves on the edge that alteration or bending which the insect was disposed to give it.If we narrowly examine these two ribbands, their effect will be visible. The second will appear very tight, and the first very slack; the reason is, because the latter has no greater degree of action, nor indeed ought to have. You now comprehend that the roll is gradually formed by the repetition of the same operations on different parts of the leaf. But it often happens that the coarser edges resist too much; the insect knows how to weaken them by gnawing them here and there. In order to form a cone, some more performances are necessary. The roller cuts with her teeth on the leaf, the part that is to compose it. She does not detach it altogether from it; it would then want a base; she only separates that part which is necessary to form the foldings of the cone. The part is properly a slip, which she rolls as she cuts it. She raises the cone on the leaf, almost in the same manner as we erect an inclined obelisk. She fixes threads or little cables near the point of the pyramid; she presses on them with the weight of her body, and thus forces the point to raise itself. You may form an idea of the rest; the mechanism is the same as that employed in making a roll.

These cells, in which the caterpillar lives, serve likewise as a retreat for the chrysalis. This latter would not probably be sufficiently well accommodated with a bare covering of leaf. The caterpillar lines the cell with silk tapestry. Other species spin a cone for themselves in it.

7. Some leaves of plants are scarcely thicker than paper. Would any one imagine there were insects skilful enough to provide a lodging in such thin leaves as these, so as to shelter themselves from the injuries of the weather A leaf is to them a vast country, wherein they make roads for themselves that are more or less winding; they mine in the substance of the leaf as our

miners do in the earth. From hence also they have taken the name of miners of leaves. They are extremely common: some belong to the class of caterpillars; others to that of worms.' They cannot bear to be naked; and it is for the sake of covering themselves, that they insinuate themselves between the two foldings of a leaf. They find their subsistence there at the same time. They eat the pulp of it, and in eating, trace out a way for themselves. Some dig there straight or crooked trenches. These are gallery miners. Others mine round about them, in circular or oblong spaces; these are miners at large. Their teeth are the instruments they mine with, but some worm-miners dig by means of two hooks resembling our pick-axes. Several of these insects spin within the mine, the cone wherein they are to transform themselves. Others quit the mine, and metamorphose themselves elsewhere. Butterflies that proceed frommining caterpillar, are little miracles of nature. She has lavished gold, silver, and azure upon them; with other colours that are more or less rich; though we regret that she has not performed these masterpieces in a more extensive form.

8. But miners have something still more wonderful to offer us. Bestow your attention on those vine leaves that are before you. They are pierced with oval holes, which seem to be made in them by a gimblet. The mining caterpillars bored these holes, by stripping two pieces of skin from the leaf, with which they make a cone: that cone is placed perpendicularly on a vine prop, at a pretty considerable distance from the leaf that furnished the materials. How was it cut, fashioned, detached and conveyed Let us not vainly attempt to guess this: let us rather endeavour to surprise the industrious labourer on her working bench. She mines by way of gallery, and constructs her cone at the extremity of the gallery. It is composed of two pieces of leaf of an oval form, very thin, even, and like each other. The caterpillar prepares these places; makes of them a thin texture, by clearing them of the pulp; she models them, lines them with silk. cuts them with her teeth as with scissors, joins and unites them. They already have no connexion with the leaf, notwithstanding which the cone does not fall: the caterpillar has taken the precaution to sustain it by some threads of the same species with its border. When the cone is finished, the caterpillar applies herself to disengage and transport it from its place. She has left a small aperture at one end of it. She causes her head to come out at this opening, bears it forward, seizes a part of the prop with her teeth, and by an effort draws the cone to her. The threads that hold it give way, and the caterpillar carries her little house about with her as the snail does her shell. Behold her walking; her march is a new mystery. It has been said. that all caterpillars have at least ten legs: this is absolutely without any, and shows us what an opinion we ought to entertain of such naturalists. Let us lay in her way a finely polished glass, placed perpendicularly. She is not in the least retarded by this, but climbs over the glass as on a leaf. By what secret art is she enabled to cleave to it, for she has neither legs nor claws to grapple it You have seen caterpillars that spin little heaps of silk which they fix themselves to. Our miner spins the like, at certain distances, according to the track the is to pass over. She seizes one of these heaps with her teeth, which becomes in part a support for her: she draws the cone to her, and carries it towards the little heap: fastens it to it; thrusts her head forwards; spins a second heap; fixes herself to it in the same manner as to the first; makes an effort to discharge the cone, which she effects, drags it towards the new heap, fastens it likewise to it, and this second step being taken, unravels to you the secret of her lingenious mechanism. By this means, she leaves on the bodies over which she passes, little tracks of silk, which she spins from space to space. When she has arrived at the place she is inclined to fix herself at, she here stops the cone intended for a habitation, and places it in a vertical situation.

There afterward issues from it a very pretty butterfly, as richly clothed, and of the same genus, as those of other miners.

9. Other insects live in great galleries of silk, which they lengthen, and widen as they grow. They cover them with gross matter, and frequently with their excrements. They construct those galleries on the various bodies they feed upon, and which differ according to the species of the insect. The name of false moths has been given to all such species as make those enclosures. You are sensible, that those of true moths are portable. The most remarkable false moths are such as settle in bee-hives, and destroy the combs; They are with. out defensive arms, and are only secured with a soft and delicate skin; notwithstanding which, nature has appointed them to live at the expense of a little warlike people, that are well armed, and equally well disposed to defend their settlements. Our engineers have frequently recourse to mines and saps in the reduction of places. It is, indeed abundantly necessary that our false moths should excel in this kind of attack, and their works prove that they do. They never march but under cover. They scoop long trenches in the thick part of the combs, in what direction they think proper, wherein they are always in safety from the enemy. The galleries of this kind are lined within with a very close silk tissue, and covered on the outside with a thick layer of grains of wax and excrements. Thus the fine works of the laborious bees are destroyed in silence, by an enemy which they are not able to discover, and that sometimes compels them to abandon their hive. The false moths have no intention to procure honey : they never penetrate into the cells that contain it. They only eat the wax, and their stomachs analyzes the matter which the chemists cannot dissolve.When they have attained their full growth, they make a silk cone at the end of the gallery, which they never fail to cover with grains of wax.

Other false moths establish themselves in our granaries, where they multiply excessively. They covet our most valuable commodity. They connect together several grains of corn ; they spin a little tube in the midst of this heap, where they lodge. By that means they are always within reach of a plentiful stock of nourishment. They feed at their pleasure on the grains of which they have been careful to form their case, and which are like a covering to it. When their metamorphosis approaches, they abandon this case; they nestle in the inner part of a grain, or in the little cavities they dig in the ceilings: these they line with silk, and there transform themselves into a chrysalis.

10. There are few insects which claim so good a right to our admiration as those that are equally skilful with ourselves in making clothes, and that undoubtedly learned the art before us. Like us, they are brought forth naked; but they no sooner come into the world, than they set about clothing themselves. They do not all dress in the same uniform manner, nor do they use the same materials in their clothing. There is perhaps a greater diversity with respect to this in the modes of different species of moths, than in those of different people on the earth. The form of their dress is very convenient: it corresponds exactly with that of their body. It is a little cylindrical case, which opens at both ends. The stuff is manufactured by the moth: the ground of it is composed by a mixture of silk and hair: but this would not be soft enough for the insect, it is therefore lined with pure silk. Our woollen furniture and furs supply these moths with the hair they employ in manufacturing their stuffs. They make a careful choice of these hairs; cut them with their teeth, and artfully incorporate them in the silk tissue. They never change their clothes; those they wore in their infancy, they continue to wear when arrived at maturity. They can lengthen or widen them as they find convenient. They meet with no difficulty in extending them; this they do by only adding

new threads and hairs to each end. But the widening them is not so easy a matter. They proceed therein exactly as we do in the like case. They slit the case at the two opposite sides, and skilfully insert two pieces of the width required. They do not slit the case from one end to the other: if they did, the sides would start asunder, and be exposed. They only slit each side about the middle of it. Reason itself could not exceed this. Their dress is always of the colour of the stuff from whence it was taken. If there. fore, a moth, whose clothing is blue, passes over a red piece of cloth, the widths will be red ; she will make herself a harlequin's habit, if she passes over cloths or stuffs of several colours. They live on the same hairs they clothe themselves with. It is remarkable, that they are able to digest them; and it is still more extraordinary that the colours do not suffer the least alteration by digestion, and that their' excrements are always of as fine a tincture as the cloth they feed on Painters may collate from our moths powders of all colours, and all. kinds of shades of the same colour. They make little journies -those that settle in cases, do not love to walk on long hairs, but cut all they meet with in their way, and are always provided with a scythe as they march. They rest themselves from time to time, when they this case with small cords, and thus cause it as it were to ride at anchor. They fasten it more firmly, when they are disposed to meta morphose themselves. They close up entirely both ends of it, is order to close in it tbe form of the chrysalis, and afterward that of the butterfly.

11. Field moths greatly exceed the domestic moths in point of industry. They take the substance of their clothing from the leaves of plants: but it becomes necessary for them to prepare this matter, and give it that lightness and flexibility proper for the garments. These moths are of the species of miners; and they insinuate them selves betwixt the two membranes of a leaf, which are to them what a piece of cloth is to a tailor; with this difference, that the latter has occasion for a pattern, which the moths can dispense with. They remove from these membranes all the pulpy substance that adheres to them, which membranes they make thin and polish. They afterward cut in them, thus prepared, two pieces, which are nearly equal, and like each other: they labour to give them the hollowness, windings, and proportions which the form of their case requires, and this form is often of an exquisite kind. They connect and unite them with incredible skill, and conclude by lining them with silk. They have then nothing to do but disengage the clothing from within the leaf where it was taken and cut, and that requires but a few efforts.

12. Many field and aquatic moths do not prepare the stuff for their clothing. Bits of wood, little sticks, fragments of leaves, pieces of bark, &c. placed on each other like titles, compose the external clothing of the case, which consists of pure silk. At other times it is covered with gravel, pebblestones, pieces of wood, little bits of reed, and small shells either of muscles or snails, and, what is scarce credible, the snails and muscles continue to live in these shells; for being, in a manner chained to the case, they are obliged to follow the moth that carries them wherever it pleases. Thus a moth in its clothing, does not appear unlike certain pilgrims. Those that are covered with wood, gravel, stones, and other unwieldly matters connected together, pretty nearly resemble a Roman soldier in heavy armour. You rightly judge, that such kinds of clothes must needs be very roughly formed: but some of them, nevertheless, look very pretty, in which the arrangement of the materials make amends for their coarseness.

Aquatic moths reap some advantage by dressing themselves in suchstrange manner. They must be always in equilibrio with the water in the midst of which they live, if their case prove too light, they 2dd a little stone to it: if too heavy, they fasten some bits of reed to it. All these moths

metamorphose themselves in their case; some into butterifies, others into flies, and others into beetles.

13. Some field moths borrow no strange matter to clothe themselves with : they dress entirely in silk : but their tissue is much closer, finer, and more glossy, than that of the most beautiful caterpillars. It has a still greater singularity; being composed of little scales, like those of fishes, partly placed on each other. The case has sometimes for its last covering a kind of mantle, which almost entirely encloses it, and is composed of two principal pieces, whose figure resembles that of a bivalve shell. Moths that procure the matter for their clothing from their own fund must be able to lengthen and widen it at pleasure; the expense attending the obtaining of it was too great to admit of their making a new one as often as there should be occasion. So that they are able to enlarge it in a wonderful manner. They do not add breadths to it, as the domestic moths do: but slit it from one part of it to another, according to its length, and immediately fill up the intervals with new threads, of a length proportioned to the space required. This case serves them likewise as a kind of cone, wherein they transform themselves into butterflies.

You have taken a survey of the produce of a multitude of different insects, and are with good reason astonished at the prodigious variety contained in them, all relative to one and the same general end, and all of them likewise as much diversified as those of our artizans. How does it happen, that among so many insects as prepare themselves for their metamorphosis, some hang by their hind part, others fasten themselves by a girdle, whilst others make themselves cones How came it to pass, that of those that construct these cones, some form them of pure silk, and others compose them of matter of different kinds Why is the form of these cones so various in different species Wherefore do some insects so artfully roll up the leaves of plants, and others only fasten or fold them together How can %ye account for the mining of these leaves by some only, and that the rest should not all mine them in the same manner! In short, how shall we assign a reason why the moths are not all clothed in the same dress

All these wherefores, and a thousand others that may be performed on the productions of nature, are so many enigmas proposed to beings that are banished into a corner of the universe, and whose sight, as short as that of the mole, can only perceive the nearest objects. and the most direct and most striking relations.

It behoves us to remain in the place that has been allotted for us, from whence we can only discover some links of the chain. One we shall discover more of them, and shall see them more distinguishes Meanwhile we may consider these proceedings of insects, so diversified and replete with industry, as an agreeable spectacle exhibited nature, to the eyes of the observer, that furnishes him with an inexhaustible source of reflective pleasure and useful instruction. led to the Author of the universe by the thread of the caterpillar, and he admires in the variety of their means, and in their tendency to the same end, the fecundity and wisdom of the Ordaining Mind. This sight becomes still more interesting, when the observer undertakes to bewilder insects, and draw them from their natural track, They then show him resources, which he had not foreseen, and that surpass his expectation. When false moths of the wax species are want of wax, they can make galleries of leather, parchment or paper A caterpillar has been seen to construct a cone of little pieces of paper which have been given him, and that have been cut at pleasure. It has taken hold of them with the teeth and fore legs, transported them to the place where it intended to fix, ranged

them there, fastened them with threads, laid some of them edgewise, others flat, forming of the whole, it is true, an assemblage that appears a little strange; but answering perfectly to a cone. It would have given it a more regular figure, had it worked with materials suited to its species. Ere we had learned to prepare and dress woolens and skins of animals, the domestic moths were not without clothing. They were then perhaps habited in the same manner as the field moths.

14.We do not expect to make any material discoveries from shell fish that are shut up in an almost stony enclosure; they seem very stupid; but they are not all so senseless as they appear to be: we shall with pleasure contemplate the proceedings of some of them.

Divers species of sea shell-fish are furnished with two pipes, by means of which they suck in the water, and which they take great care to keep raised above the vessel they are accustomed to sink into more or less. Some spirt out the water to the distance of several feet. That particular part, which in some performs the progressive or retrograde motion, very much resembles a real leg with a foot joined to it ; but this leg is a Proteus, which assumes all kinds of forms to supply the necessities of the animal. It does not only make use of it to crawl with, sink into a vessel, or retire from it; but employs it with much greater skill to perform a motion that one would not imagine a shell-fish capable of. A shell-fish that leaps, must appear very extraordinary. It is a tellina that you are now seeing. You may observe that she has placed the shell on the top or point. She stretches out her leg as far as possible; she causes it to take hold of a considerable part of the circumference of the shell, and, by a sudden motion, similar to that of- a spring that is slackened strikes the ground with her leg, and thus leaps to a certain distance

15. The cutter never creeps: it penetrates perpendicularly into the sand. It there digs itself a sort of cell, which is sometimes two feet long, in which it goes up and down at pleasure. Its shell, whose form a little resembles that of a handle of a knife, has occasioned it to receive the name of cutler. It is composed of two long pieces, hollow like a gutter, and joined together by membranes. The body of the animal is enclosed in a case. The part whereby it exercises all its motions, is placed in the centre. This is principally designed to perform the office of a leg, and acquits itself exceedingly well. It is fleshy, cylindrical, and pretty long. The extremity of it, when necessary, can roll itself up like a ball. View the cutler when extended on the sand. You behold it working, in order to pierce into it. It thrusts out its leg at the lower end of the shell; stretches it, and causes the extremity of it to assume the form of a shovel that is sharp on both sides, and terminates in a point. It directs it towards the sand, and applies the edge and point for introducing it farther. After the aperture is made, it extends its leg still more, and causes it to penetrate deeper into the sand: he bends it like a hook, with which taking hold of a support, he draws the shell to him, forcing it upright by degrees, and afterward causes it to descend into the hole. Is he disposed still to continue sinking; he thrusts his whole leg out of the shell; fixes in the sand the ball which is then at its extreme part; immediately contracts this leg; his large head, which is strongly fixed in the whole, being less inclined to reascend than the shell is to go downwards, the cutler descends into the sand, which is his first step into it; he has nothing to do but to repeat the same operations, in order to advance farther and farther into it. Is he disposed to go up again to the surface; he pushes forth the ball, and at the same time makes an effort to extend his leg; the ball, which is averse to a descent, presses the shell towards the top of the hole,

It is pretty remarkable, that the cutler, which lives in salt water dreads the touch of salt. If a pinch of it be cast into his hole, he will come out of it immediately. But if he be caught, and afterward permitted to re-enter his cell, it will be in vain to throw salt into it, since he will not quit it on that account. it is said by some, that he remembers having been taken; and this is so true, that when people do not catch him, he may be made to come out at one's pleasure, by throwing some fresh salt into the hole. It seems, then, that he is aware of the snare that is laid for him, and is unwilling to be taken by it.

16. Cast your eyes on this stone, which I have just now taken up from the sea shore. A shell-fish fixes his habitation in it. Observe, that en the surface of the stone there is a very little hole it is by that the shell-fish has entered, and you may judge of the smallness of it by that of the aperture. We will break the stone asunder, that we may see the animal that dwells in it. How great must your surprise be! You behold a great shell-fish, near three feet in length, whose shell is formed of three smooth pieces joined together by a ligamentary membrane. It is lodged in a great cavity, that is hollow like a funnel The upper part of the cone is in the little hole you see on the surface of the stone. This shell-fish is a dail or pholas. How could it be able to pierce so hard a stone Or how go through so narrow a passage Draw near this clayey shell which the wave has just left. It is pierced through with a multitude of such holes as you see in the stone you have in your hand. All these holes are inhabited by young dails, which are only a few lines long. They had then no occasion to penetrate into a hard stone. Moist clay makes but little resistance. But the sea insensibly converted this clay into stone: the dail, which at first found himself lodged in a soft earth, afterward perceived that he was within a stone cell. We have seen that the cutler can come out of his hole when he pleases: the dail never quits his; nor indeed can he; since the form of this kind of cell will not admit of it. All that he can do, is to stretch out two pipes at the opening of the bole, with which he receives and rejects the water. The cutler does the same. You are impatient to be informed of the instrument with which the dail hollows his cell. This instrument has no edge to it: it is purely fleshy, and shaped like a lozenge.

17.We will quit shell-fish for a time. Divers animals of the sea will likewise entertain us with the wonders of their Author. Let us bestow on them the attention they deserve: what we are about to relate concerning them, will be found well deserving notice in natural theology. On the rocks near the sea shore you may perceive little fleshy masses, of the size of an orange, whose form is like that of a counter-bag, and pretty nearly resembling that of a cone when cut. All these masses seem immovable, and connected with the rock by their base. Some of them are rough, others smooth. We have just now compared them to a bag, or purse, in which counters are put; but this bag is not folded together, and is likewise without strings. They are nettles that you see; a very singular kind of animals, that demand a closer attention. The body of the animal is in effect enclosed within a sort of fleshy purse, of a conic figure; at the top of the cone is an opening, which the nettle increases or contracts at pleasure.

Let us consider the sea-nettles that we have now before us. There is one that opens and unfolds itself like a flower: it has put forth a hundred and fifty fleshy horns, like those of snails, distributed in three rows round the aperture. You remark, that little water.spouts issue from these horns; consequently they do not perform the same functions as those of snails; they are analogous to the pipes of cutlers, and other shell-fish which you have seen. You also remark' that the form of these nettles varies greatly, that their base is some times circular and sometimes oval, and that the

height of the cone varies according to the dimensions of its base. It rises or falls as the base grows narrower or wider. Touch one of these blown nettles see with what quickness it closes and contracts itself. But you perceive no progressive motion: are the nettles then condemned to pass their whole life fixed to the same spot The ancients thought so. What are we to think of them About an hour ago, this large nettle, which you see on your right-band, touched this point of the rock: observe that it is now above an inch distant from it. You are surprised that you did not perceive it walk, for you looked at it more than once; the reason of this is, because its progressive motion is as slow as that of the hand of a clock. We may be curious to know how the nettle perform it. All its body is externally furnished with various orders of muscles. Those of the base go, like rays from the centre to the circumference; others descend from the top towards the base. These muscles are also canals full of liquor, which issues out on pricking them. They are emptied and filled at the pleasure of the nettle. By the exercise of these muscles or canals the progressive motion is performed. Let us follow the nettle when she is disposed to go forwards. Her base is circular. She swells the muscles that are on that side whither she is tending. She injects her liquor into them, which, by inflating, lengthens them. They cannot extend themselves unless the edge corresponding with the base, shifts its place and advances a little way. At the same time she loosens the opposite muscles, and empties their canals. They contract. This they cannot do, except the edge of their corresponding base goes in a little, and exactly in the same degree as the opposite one projects. Such is the mechanism whereby the first step of our nettle is performed. In order to make a second, she causes the base again to receive a circular form, by puffing up equally all the canals; she afterward repeats the same operations we have just taken a view of. The whole progressive motion of nettles is not confined to this. They have another method of walking, which nearly resembles that of insects. They are able to make use of their horns like legs. But these horns are on the upper part of their body: the nettle is fixed by its base against the rock: bow do these horns perform the office of legs The nettle you are following will show von the method. She turns herself upside down; the base abandons the rock, and the cone is placed on its top. All the horns shoot forth, and you see them fix themselves to the rock. They are gluey and rough to the touch: for which reason they meet with no difficulty in fastening to it.

18. Would you believe that an animal which is entirely of a fleshy nature, and is provided with no instrument to open or pierce the shells feeds upon shell-fish Nettles that are but of a middling size swallow great shell-fish, and it is difficult to conceive how they are capable of being lodged within the nettle. It is true, the latter being entirely fleshy is susceptible of a great distention. It is a sort of supple purse that may be stretched occasionally. The opening of the purse is properly the mouth of the nettle. Its inside not being transparent, one can not see what passes therein, or by what means the nettle voids the shell-fish. The moment she has swallowed it, she closes herself Look at this young nettle that is shut up quite close: she has just swallowed a pretty large snail, and is busy in digesting it. She is now opening herself again, and discharging the empty shell. On the side of her is another nettle which bespeaks your attention: she has swallowed a great muscle, and is making ineffectual efforts to void the shell. She is not able to effect it: the shell presents itself in an unfavourable position at the aperture, and you begin to be in pain for the unhappy nettle. She has a resource that you did not imagine. Cast your eyes towards the base; the shell is evacuated through a large wound; the nettle is delivered from it by that means, and is no more affected by the great gash made thereby, than we are by a scratch.

10. All nettles do not procure a discharge by so violent a method they have another which they commonly use with success. They turn themselves inside out like a glove or stocking, so that the edges of the opening, which resemble lips, fold themselves on the base. The mouth is then of a prodigious width, and the bottom of the purse almost uncovered.

Nettles do not thus shift themselves merely to get rid of heterogeneous bodies; they put themselves into the same posture when they bring forth. They are viviparous. The young are produced completely formed; and we see nettles in miniature appear. The aperture through which they pass, is so wide as to admit a multitude of them at the same time. Notwithstanding which they always come forth singly. They are at first enclosed in certain folds concealed at the bottom of the purse. Do nettles resemble polypuses by the singular property of being multiplied and grafted by slips Experiments have put this beyond all doubt. Of a single nettle, divided according to its length or width are made two or three, which at the end of a few weeks are perfect and complete. They may likewise be grafted; ‘but it will be necessary to have recourse to seaming. You are now no longer surprised at the consolidation of that enormous wound made at the base of a net-tie that issues out thereat. A wound of this nature is nothing, when compared to that which another animal sustains when cut in pieces, without ceasing to live and multiply in each piece. Nettles may then be called a species of polypuses, with arms of a monstrous size; or, If you prefer the expression, polypuses with arms are a species of very minute nettles.

Let us quit these rocks that swarm with nettles, and betake ourselves to that little creek where the sea is very calm. Stooplittle, and observe the surface of the water. What do you perceive A kind of greenish jelly floating upon it. Its form is like that of a broad mushroom. It is near two feet in diameter. Take a piece of it betwixt your fingers; handle it for a few minutes: you will see it dissolve into water. The heat of your hand was sufficient to melt it. Does it enter into your thoughts that this jelly is a real animal, and even a species of nettle It has been called wandering nettle, because it never fixes, and floats from one side to the other. Its convex surface presents us only with an infinite number of little grains or nipples. But its inferior surface, which is concave, is extremely organized: in that we may see a great number of canals, which are regularly disposed, and made with great art, some being circular, and others disposed regularly, like the felloes of a wheel, and which are full of watery liquor, which passes from one to the other. This strange animal wanders about in the sea. It is specifically much heavier than water. He cannot therein sustain himself without the assistance of a spontaneous motion, which is worth observing, and cannot be seen but in places where the water is calm. It is so in this little creek, on the extremity of which we are sitting. Look with attention on the surface of that jelly which offers itself to your view. Observe that it has certain motions, which you are tempted to compare with those of the systole and diastole. However, they are not the same. Their only end is to cause the nettle to float. You see that in the systole kind, the surface of the animal becomes very convex, and that in the diastole it becomes suddenly fiat and wide. Such is our glutinous nettle’s method of floating. When dried in the sun, it is reduced almost to nothing. We imagine that we see a little piece of parchment or very transparent paste. There is no room to doubt that (his species of nettle multiplies like the rest, by slips; but I do not know that there has been any experiment made concerning this. A jelly must be attended with greater ease in regenerating itself than organized bodies of the same genus, that are of a more firm or close consistence.

20. There are no regular or strange forms of which the animal kingdom does not afford us models. Here is an animal whose form is precisely that by which we paint the stars in the firmament. It is nearly flat. From the middle of its body proceeds four or five rays which are almost equal, and resembling each other. Its upper surface is covered with a hard, callous, and very rough skin. In the centre of the inferior surface is placed the mouth, which is provided with a sucker, that the star makes use of to imbibe the substance of the shell-fish she feeds upon. Five small teeth or pincers hold it confined whilst she such them, and perhaps assists in the opening his shell. The legs of the star are a real curiosity. They are joined to her inferior surface' and distributed with symmetry in four rows, each consisting of seventy. six feet; so that each ray is furnished with three hundred and four feet, and the whole star with fifteen hundred and twenty. Yet with such a number of feet, the star goes but little faster than the muscle, which has only one. These legs perfectly resemble the horns of the snail, both by their figure, consistence, and exercise. When the star is disposed to walk, she spreads her legs as the snail does her horns, and with the extremity of them seizes the various marine bodies on which she crawls. She commonly puts forth only one part of her legs; the remainder are kept in reserve against those necessities which. may happen. The mechanism which presides over their motions Is an illustrious proof of a Creative Mind. Let us open one of the rays by slitting it lengthwise, and we shall display the principal springs of the machine. An almost cartilaginous partition, made in the form of, vertebrae divides the whole ray. In every part of this partition, you perceive two rows of little balls, like pearls of the finest water. The number of these little balls is precisely equal to that of the legs. Thus you see that each ball answers to a leg. You can distinguish a limpid liquor in these balls ; press your finger upon them ; they empty themselves; the liquor passes into the corresponding legs, and they immediately extend themselves. The star then need only press the balls in order to spread the legs. But they are capable of contraction, and when they contract themselves, 'they force the liquor back again into the balls, from whence it may be driven afresh into the legs, to procure a progressive motion.

You conjecture, that these eggs, which resemble these tubes, through which divers kinds of shell-fish respire, serve likewise for the same uses. But nature who has been so lavish in providing the star with legs, has also been liberal in bestowing on it the organs of respiration. She has even multiplied them in a greater degree. They are very small conic tubes, disposed in knots, and produce an equal number of little water-spouts.

Amongst our stars, you observe there are some which have only two or three rays, and by looking more narrowly at them, you discover several very minute rays, just beginning to shoot out. Are then animals that are formed by a repetition of such a great number of parts both outward and inward, regenerated like polypuses, whose structure appears so simple Nothing is more true, and the stars you are now looking at, will afford you a proof of it. These animals often chance tb lose two or three of their rays, and they are no more affected by this loss than polypuses are by parting with some of their arms. We may mangle stars or cut them in pieces, hut cannot destroy them by that method. They will recover from their ruins, and each piece becomes a new star.

21. Sea-hedgehogs, like the land ones, derive their names from their prickles. But those of the former are quite different from such as belong to the latter. The form of these hedgehogs is that of a round button. It is hollow within, and its surface is elaborately wrought. We might compare the workmanship of them to that of certain copper or wire buttons. A multitude of tubercles. like little triangles, divide the whole surface of the button. These triangles are separated by stripes, which

are regularly spaced, pierced with holes, and distributed with great symmetry in several lines. These holes pass through from one part to another, the whole thickness of the skeleton, for the body of our hedgehogs is a kind of bone-box. Each hole is a socket, wherein is a fleshy horn, like those of a snail, and susceptible of the same motions. There are therefore as many horns as holes, and there are reckoned to be at least three hundred. The hedgehog, like the snail, makes use of her horns for feeling the earth, and the various bodies it meets with in its passage. But it particularly employs them to fasten with and cast anchor. The tubercles are the bases of many prickles or legs, and their number amounts to at least two thousand one hundred. So that there is hardly any part of the body of a hedgehog that is destitute of a leg. It can for that reason walk as well on the back as on the belly; and in general, let it be in what posture it will, it has always a great number of legs able to carry it, and horns to ‘fix it with. The legs it uses with the greatest ease, are those which surround the mouth; but when it pleases, can walk by turning on itself like a wheel. On the back or the top of the button, is another aperture which is thought to be the anus. This then is an animal that is provided with at least thirteen hundred horns, and two thousand one hundred legs. What a great number of muscles must it require to move so many horns and legs How many fibres must there be in each of these muscles What an astonishing multiplication of parts in this little animal! What regularity, what symmetry, and even harmony in their distribution ! What variety in their exercise When the hedgehog would advance, he draws himself forwards with those legs that are nearest the place he would go to, and pushes himself towards it with the opposite ones. All the rest remain at that time in a state of inaction. At the same time that one part of his legs are at work, the horns that are nearest to them exert themselves sound the way, or find anchorage for the animal.

22. Most shell-fish are produced with their clothing. The shell they bear grows with them and by them. But Bernard, the hermit, a kind of crayfish, so called, comes into the world without a shell, though he has need of one in order to cover the greater part of his body; whose thin and delicate skin would suffer too much from being naked. Has nature then behaved to it as a step mother, by denying it so necessary a garment By no means: as she is beneficent to wards every other animal, so has this likewise been the object of her attention. It is true, she has not provided it with a shell; but has made it amends by enabling it to ‘clothe itself with one. Taught’ by so great a mistress, our hermit has the sagacity to take up hit lodging in the first empty shell he meets with. He applies him self indifferently to all that are of a spiral construction. He often retires so far into them, as not to be perceived, whereby the shell appears empty. If the shell should prove too narrow, be quits it, in order to seek for another, more suitable to his bulk. It is said, there’ sometimes happen contests between our hermits about a shell, and that victory is decided in favour of him who has the strongest claws. Our battles have scarcely ever a cause of equal importance for their object.

23. You have been already astonished at the skill displayed in the progressive motion of several shell-fish, your amazement will be redoubled when you learn that some of them can spin: and you are impatient to see them at work. Let us walk on the sea shore. You there discover a number of muscles, ‘some by themselves, and others joined in companies. Consider them more attentively, you will observe that some of them are fastened to stones or to each other, by a great number of small slender strings. Let us select one of these muscles, that we may observe it more closely; the better to discover their operations. Here is one of them endeavouring to fix itself to this stone, that is near the surface of the water. The shell is partly open; it has thrust out from it a kind of supple

tongue, which it lengthens and contracts alternately. Remark that it often applies the ends of it to the stone, and immediately draws it back again into the shell, that it may again put it forth at the next moment. From the root of this kind of tongue there issue certain threads, which are equal in size to a hog's bristle. These threads part from each other as they come out, and their extremity sticks to the stone. These are as so many cables which hold our muscle at anchor. There are frequently an hundred and fifty of these little cables employed in mooring a muscle. Each cable is scarcely two inches long. The muscle herself has spun all these cords. The tongue not only serves them as it does other shell-fish for arms to fasten themselves with, and for legs to creep with; but is also the spinning instrument which produces those numerous threads, by means of which the muscle resists the impulse of the waves. From the root of the tongue to its extremity, there is a groove, which divides it according to its length into two equal parts. This groove is a real channel, furnished with a great number of small muscles that open and shut it. Is this channel is contained a viscous liquor, which is the matter of the threads emitted by the muscle. At its first appearance, this channel is exactly cylindrical, and is, properly speaking, the place where the threads are moulded. The various motions the tongue of the muscle we are observing gave itself a minute ago, all tended to fix it to the stone. Those threads which are the whitest and most transparent are such as are newly spun. She has not yet finished anchoring herself, wherefore you perceive her tongue is again extended about two inches, and the tip of it drawing towards the stone. The viscous liquor runs in the channel, and arrives at the extremity of it. This liquor is now consolidated, and becomes a cylindrical thread. The muscle sticks the end of his thread to the stone; but is desirous of applying it by a wider surface, in order to render it more adherent. For that purpose, she adds to it with the tip of her tongue, that little paste which you observed. Her business now is to extend another cable to some distance from the last. The tongue therefore, must quit this latter, in order to work elsewhere. How will she be able to effect this The channel opens itself to its utmost length, and discharges the thread. The tongue being disengaged from his thread, quickly draws itself together, re-enters the shell, and the next moment again issues from it, to fix a new cable a little farther off. Did you take notice of a mark of skill expressed by our muscle; she has just now spread the first thread; to assure herself of the goodness of it, she immediately puts it to the proof; drawing it strongly towards her, as though she would break it. It has resisted this effort, and, satisfied with the experiment, she has proceeded to stretch out the second thread, which she has tried like the first.

These cords, which the sea-muscles spin with so much art are, in reality, as serviceable to them as cables are to a ship. You ask me, whether they can weigh anchor Divers experiments prove they are not endowed with that ingenuity. It was not necessary for them. But they sometimes drive with their anchors; it therefore behoves them to have fresh cables in reserve.

Thus the sea has its spinners as well as the earth. Muscles are at sea the same as caterpillars are on land. There is, nevertheless, a remarkable difference between them. The work of caterpillars answers exactly to that of gold wire-drawers. The silk thread is moulded by passing through the mouth of the spinner, and the caterpillar gives it what length she pleases, which in certain cones consists of several hundred feet. The labour of muscles may rather be compared to that of workmen who cast metals. The spinning instrument of the shell-fish is a real mould, which does not only determine the thickness of the thread, but also its length, which is always equal to th at of the spinning instrument or tongue The pinnae marinae, which are species of very large muscles,

are more dexterous spinners still. Their threads, which are at' least seven or eight inches long, are extremely fine, and curious works are made with them. If muscles are caterpillars of the sea, pinnae are its spiders. The threads of the pinnae serve, like those of muscles, to moor them with, and defend them from the agitations of the waves. They are prodigiously numerous, and being united, kind of tuft or skein, weighing about three ounces. The instrument that prepares and moulds them, resembles, in the essential properties of it, that of other shell fish of this kind: except that it is much larger, and the groove that divides it lengthwise is much narrower At the root of it there is a membraneous bag, composed of several fleshy layers, that separate the silk layers from whence the tuft results.

24.If all kinds of shell-fish and sea-animals have not been enabled to moor themselves with as much skill as muscles and pinnae, nature has made them amends for that by affording them means that are less efficacious. Before we quit this shore, let us stop a little while and examine this small shell-fish which you see fastened to this rock. It is a goat's eye, or a limpet. Its shell, which consists of one piece only, is made like a conic chapter, under which the whole body is sheltered, as under a roof. The animal can raise or lower this covering as it pleases. W hen it lowers it, the body is entirely. concealed, and it rests immediately on the stone. A large muscle that occupies the whole extent of the shell, and that is, as it were, the base of it, fastens the animal to this stone. Try to disengage it from. it: you are not able to effect it. It is nevertheless only fixed to the stone by a base of an inch and a half in diameter. Let us hoist cord round the shell; and suspend a weight of twenty-eight or thirty. pounds to this cord, the shell-fish will not quit its hold till after some seconds, and you are surprised that so small an animal should be endowed with so great a power of adhesion. You are curious to know from whence he derives this: you examine the stone, and it appears to you to be finely polished, whereupon your astonishment is redoub!ed. Can it be that the muscle is able to insinuate itself into the insensible parts of the stone Divide the animal transversely: it still adheres as strongly as before. Does it cleave to the stone as two pieces of polished marble cleave to each other But, pieces of marble easily slip each other; and you cannot cause the shell-fish so to do. This thee is the secret cause of that adhesion which astonishes you. The muscle is furnished with a viscous humour, which agglutinates it to the surface of the stone, and which is sensibly felt by touching it with the finger. But the goat's eye has not been condemned to remain its whole life affixed to the same place. It is necessary for it to go in search 0f its food. There is one now creeping on the rock: its great muscle serves him instead of legs, and performs the same functions as that you have been made acquainted with in the snail. The goat's eye then can disengage himself when he pleases. It is able to break those strings which are with difficulty disjoined by a weight of eight and twenty pounds. Moisten your finger,. and stroke the muscle with it; the natural glutinous substance, with which it is endowed, can no longer retain its hold. This glue is dissoluble by water. The whole surface of the muscle abounds with little seeds, filled with a dissolvent liquor. When the animal is disposed to shift his quarters, he need only press his numerous glands, the dissolvent issues from them, and the cords are broken. The goat's eye has but one certain provision of gluey matter. If it be loosened from its place several times together, its stock will be exhausted, and it will not fix any more. This method of mooring is common to divers sea animals. it is particularly so to nettles. Its whole skin is one entire mass of glue, which dissolves very speedily in aqua vitae. It is with this abundant glue that these extraordinary animals fasten themselves to the rocks.

Star-fishes also fix themselves by the same method. A viscous matter is conducted to the extremity of the horns that serve them instead of legs. These legs become strong ties to them by means of the glue that exudes from them, and when they are once fastened, it is easier to break than separate them. The horns of hedgehogs are exactly of the same nature.

All these adhesions are voluntary, and depend solely on the good pleasure of the animal. He joins or disjoins himself as circumstances require. But there are other adhesions, which are altogether involuntary. Sea-worms that are called pipe-worms, are enclosed in a round tube of a substance resembling that of shells, and fastened to stones or hard sand, or even to other shell-fish. This tube follows the turnings of the surface to which it is fixed. The worm never quits this shell, which lie lengthens or widens as he grows. They recall to your remembrance, the false moths: this may be termed a false moth of the sea. It emits from its whole body a stony juice, which is the matter whereof the tube is formed.

Other worms of this species, whose juice is not of a stony nature, but glutinous, make use of it for collecting round them grains of sand, or bits of shells; and this shell of inlaid pieces is not withstanding wrought in pretty exact proportion.

Oysters, and many other shell-fish, adhere by a stony liquor to bodies whereon they rest, and are often by this means cemented to one another. Of such a species is that universal cement which nature makes use of as often as she would erect in the sea, or establish therein a shell-work against the violent motion of the waves.

We have acquired but little knowledge of the industry of fishes They are not sufficiently within our reach. The greatest part of their inhabit gulfs that are inaccessible to our researches. We do not presume to think, that all their intelligence is confined solely to the devouring of each other. Their migrations are also as remarkable those •f birds. They may have need of a kind of genius to enable them to chase their prey with success, and elude the pursuit of their enemies. The cuttle-fish scatters about; at a proper season, a black liquor, which troubles the water, and hides her from the sight of such fish as attempt to take away her life. Perhaps this liquor may be serviceable to her in seizing with the greater ease those she feeds upon. Other fishes can with abundance of art penetrate into very hard shells, and extract from thence the fleshy substance contained in them. We are not yet acquainted with the use the sword-fish, the saw-fish, and the narval, or unicorn-fish, make of those enormous instruments they wear at the end of their snouts; but they are undoubtedly able to handle them. Has not the cramp-fish which so suddenly benumbs the hand that touches it, a very remarkable method of providing for its safety, and an excellent art to propose to the meditation of the natural philosopher The flying-fish, when pursued by others, darts out of the watery element to take refuge in the air, where it is for a time sustained by its great tins.

It is well known that carp are capable of being tamed, and that they will hasten like fowls, at a certain signal, to receive food from the hands of their provider.

It is probable that fishes are of all other animals endued with the longest lives. We have seen carp of an hundred and fifty years old. Fishes transpire and harden but little; they have, properly speaking, no bones. But they live in a state of perpetual warfare. They all devour, or are devoured by others. Those who attain to their age, must acquire an extensive knowledge of things relating to

the sea. Such nestors as these may be able to procure us some good memoirs of the secret history of the people so Little known.

25. We conjecture that the emigration of birds depend principally on the winds. An exact naturalist at Malta has assured himself of this : that the same species always change their climate with particular winds. In April the south-west wind brings into that island a species of plovers, and the north-west, cardinals and quails. Nearly at the same time, falcons, buzzards and other birds of prey come with the north-west wind, without stopping and depart in October with the south and west. In summer, the easterly wind conducts the snipes to Malta, and, towards the autumn, the north and north-west bring thither numerous squadrons of woodcocks. These birds cannot fly, like the quails before the wind; since the north wind, which might carry them into Barbary, obliges them to remain in the isles. Quails, on the contrary, emigrate before the wind from one country to another. The south-east enables them to pass, in the month of March, from Barbary into France. They return from France in September, and go to Malta by a south-east. The winds, therefore, are the signals employed by nature for reminding divers kinds of birds of the time of their departure. In obedience to this voice, they set out, and follow the direction it points out to them.

What a series of interesting circumstances would not the construction of their nests also present us with! A chaffinch or goldfinch’s nest would take us up whole hours in contemplating it. We should inquire where the goldfinch could furnish itself with a cotton so fine, silky, and soft, as lines the inside of its pretty nest. After many researches, we should find, that by covering the seeds of certain willows with a very fine cotton, nature has prepared for the goldfinch the down she employs. We should never be weary of considering that kind of embroidery with which the chaffinch so agreeably adorns the outside of his nest, and on viewing it more narrowly, we should perceive that it is owing to an infinity of little liverworts, artfully interwoven together and applied with the utmost propriety over the whole surface of the nest. The colour of these liverworts, which is most commonly that of the bark of the tree on which the nest is situate, would indicate that the chaffinch seems to intend her nest should be confounded with the branch that bears it.

26. Shall we visit the retreats of rats, field-mice, badgers, foxes, otters, bears. We should undertake thereby too tedious a journey. Let us limit ourselves to the rabbit and monkey, as the most curious after those of the beaver. The rabbit and hare, which bear so near a resemblance to each other, both in their exterior and interior part, teach us not to trust to appearances. They easily couple together, and produce nothing. They are therefore distinct species.

Moreover, the feeble hare contents herself with the lodging she makes for herself on the surface of the earth. The more industrious rabbit penetrates into the earth, and there procures an assured asylum. The male and female live together in this peaceable retreat, fearless of the fox or bird of prey. Unknown to the rest o the world, they spend their days in happiness and tranquility. The hare might also dig the earth, but does not, neither does the dometic rabbit since he has no occasion; his dwelling place being provided for him. he behaves as if he were sensible of it. The warrenrabbit seems to know that he is unprovided, and procures for himself a lodging. But to perceive the relations those retreats have to their preservation, anti to judge that they will shelter them from all inconveniences they labour under, is an operation of the soul that borders on reflection, if it be not reflection itself. When the hare is ready to kindle, she digs for herself a burrows This is a winding trench, or one made in zigzag. At the bottom of trench she works a great cavity, lining it with her

own hairs. That. is the soft bed she prepares for her young. She does not quit them during several of the first days ; and only goes out afterward to procure nourishment. The father at that time knows nothing of his family he does not dare to enter the burrow. When the mother goes into the fields, she often takes even the precaution to atop up the. entrance of the burrow with earth steeped in her urine. When they are grown somewhat larger, the leverets begin to browse the tender grass. The father at that time acquires a knowledge of them, takes them up in his paws, licks their eyes, polishes their hair, and distributes his caresses and cares equally amongst them all.

Observations prove that paternity is greatly respected amongst bares. The grandsire continues to be the chief of the whole numerous family, and seems to govern it like a patriarch.

27. The tricks of the monkey are known to every body. No one is ignorant with what facility she is tamed, and taught to dance and show postures on a staff. Her ingenious proceedings on the tops of the Alps. where she fixes her abode, in the midst of snow and frost, are not so generally known.

Towards the month of October, she enters into winter quarters, and shuts herself up for the remainder of the season. Her retreat is worthy of observation. On the brow of a mountain, the industrious monkey establishes her dwelling. It is a great gallery dug under ground, and made like a Y. These two branches, which have each of them an opening, terminate at a corner. Such is the apartment of the monkey. One of the branches descends below the apartment, according to the sloping of the mountain; it is a kind of aqueduct that receives and carries off the excrements and filth. The other branch, which rises above the habitation, serves for an avenue and place to go out at. The apartment is the only part of the gallery which is horizontal. It is lined with a thick layer of moss and hay. It is certain that monkeys are sociable animals, and that they work in common on their lodging. They amass, during the summer, ample supplies of moss and hay. Some mow the grass, others gather it, and by turns they supply the office of a cart to convey it to the storehouse. One of the monkeys lies on his back, opens his paws to serve instead of racks, suffers himself to be loaded with hay, and drawn by the rest, who hold him by the tail, and are careful to prevent the carriage being overturned on the road.: Their feet are armed with claws, which enable them with great ease to dig into the earth. As soon as they have made a hollow place in it, they throw behind them the dirt they extract from the mine. They pass the greatest part of their life in their habitation; they retire into it during the rain, or on the approach of a storm, or at the sight of some imminent danger. They seldom quit it except in fine weather, and go but a little way from it. Whilst some are sporting on the turf: others are busy in cutting it, arid a third party are acting as scouts on the eminences; to give notice to the foragers, by a whistle, of the enemy’s approach.

During the winter, monkeys eat nothing. The cold benumbs them, suspends or greatly diminishes perspiration, and other excretions. The fat with which their belly is well provided passes into the blood and restores it. We might affirm that they foresee their lethargy, and are apprized that they shall then have no need of nourishment ; for they do not think of hoarding up provisions, as they do materials for furnishing their lodging.

28. We have greatly admired the ingenious and almost intelligent mechanism, by which divers caterpillars roll up the leaves of trees. You see these ash leaves that are rolled up like a coffin. They are inhabited by a little caterpillar, that has formed for itself therein a cone of pure silk, nearly resembling a grain of corn. We cannot examine this cone without opening the coffin. Let us do it

with caution. The cone is lodged in the centre. You perceive little gutters on the exterior part of it. Observe particularly in what manner this little cone is suspended in the middle of the coffin, by the help of a thread, one of whose extremities is fixed to the top of the cone, and the other to its base, or the flat part of the leaf. Look narrowly at the place where the thread joins to the flat part of the leaf; you will perceive a small piece in it exactly circular, bored in the thick part of the leaf, and that seems' to conceal some secret design. This you will find in many coffins; but it often happens that you will see in that place a little round hole, well turned, that appears to have been made by a gimblet. The circular piece is the work of the caterpillar; it has skillfully gnawed that part of the leaf; and has cut a little piece of it in a circular form, which it has been very careful to leave in its place. You seem to discern the end of this labour. It is contrived for a private passage for the caterpillar to go out at, at the same time that it prevents the entrance of any mischievous insects. Our industrious caterpillar then makes a little door into its cell. The door is not to be opened till after the last metamorphosis. The winding parts of it being interwoven with the leaf, it remains as it were subservient to it. In issuing from the cone, the caterpillar descends by the whole length of the thread, which holds it suspended; it follows the direction of it, arrives at the door, and bursts it open by pushing its head against it. These coffins, which you see pierced through, have been abandoned by the caterpillars.

29.Our grain is liable to be eaten by a very small insect, that lodges within it, and is there metamorphosed. The covering of corn is a kind of very close box, which the caterpillar lines with silk. the caterpillar is provided with no instrument to pierce through this box, and would remain prisoner therein, if the insect were not instructed how to prepare a passage from it. It proceeds in the same manner as the roller of the ash ; it cuts with its teeth a little round place in the' covering of the grain, which it is very careful not to' disengage entirely from it. The butterfly need only press against this part, in order to obtain its liberty. In the centre of the capper-thistle there is a large oblong cavity, which is commonly inhabited by a small caterpillar, that makes a sort of cone therein, where she transforms herself. The rind of the thistle is much harder than that of our corn. It would be impossible for the butterfly to force a passage through it. It would have occasion for very strong teeth for that purpose, and is furnished with no analogous instruments. The caterpillar, which seems sensible of this, makes a skilful provision for the necessities of the butterfly. It pierces in different parts the walls of its lodge, and makes a small round hole in it, opposite the extreme part of the cone which the butterfly is to go out at. But, were this whole to remain open, the chrysalis would be too much exposed. The caterpillar contrives a very simple expedient for stopping up the aperture. The whole exterior part of the head of the thistle is covered with the seeds of the plant. The caterpillar brings some of these little bodies to the outside of the hole. In treating of the proceedings of aquatic moths, we have remarked that they transform themselves in their case, There must be a continual fresh supply of water in this enclosure: yet, no voracious insect should be allowed access to it. Instead of placing a full made door at the entrance of its lodge, the moth puts a grated one there, which answers every end. Let us not attribute our method of reasoning to this moth. Does she know that voracious insects have a design against her life Is she sensible that she will put on a form under which she will not be able to fly No; she is ignorant of all this; nor does it concern her to know it. She has been taught to spread threads that are capable of growth; she does spread them; in so doing, she provides by a machine against the inconveniences which she neither knows or can know. Judge on the same principle of other facts of this kind. It is always the Author of the insect who alone is to be esteemed wonderful.

30. I need not then endeavour, from the end which we discover in the work of an industrious animal to find a reason for this work.The spider catches the flies because she spreads a net, &c. and she forms a net because she has occasion to spin. The end is not less certain, or less evident; only, it is not the animal that has proposed it, but the Author of the animal. What loss would natural theology sustain by this method of reasoning Would it not, on the contrary, acquire a greater degree of exactness Let us reason then on the operations of animals as we do on their structure. The same Wisdom which has constructed and arranged with so much art their various organs, and has caused them to concur to one determinate end, has likewise caused those numerous operations, which are the natural effects of the economy of the animal, to contribute to one end. He is directed towards his end by an invisible Hand he executes with precision, from the very beginning, the works which we admire; he seems to act as if he was capable of reasoning, to turn about with propriety, and to change his method as there is occasion, and in all this only obeys those secret springs by which he is actuated; he is only a blind instrument that cannot judge of his own action, but is excited to it by that Adorable Mind which has traced out to every insect his little circle, as he has marked out to each planet its proper orbit. When therefore I see an insect working on the construction of a net, a cone, or a chrysalis. I am seized with respect, because I am beholding a sight where the Supreme Artist is concealed behind the scene.

31. Many species of solitary bees content themselves with penetrating into the earth; scoop out cylindrical cavities therein, and polish the walls. They deposit an egg there and amass a sufficient quantity of nourishment.

There is another species of these worms that pierce the earth. whose industry is much more remarkable. They do not content themselves, like the others, with an entire naked cavity. On visiting the inside of the lodge, immediately after its construction, we are agreeably surprised to see it hung quite round with tapestry of the most beautiful crimson sattin, affixed to the sides as our tapestry is to the walls of our apartments, but with much more propriety. The bee does not only line in this manner the whole inside of her dwelling; but also spreads the same kind of tapestry round the entrance, to the distance of two or three lines. We have observed many caterpillars that line the inside of their cone or enclosure with silk : our bee is the only insect at present known, which properly speaking, hangs her nest with tapestry, as we do our apartments. It is therefore with good reason that this industrious animal has received the name of the tapestry bee.

You seem at a loss to know from whence she procures the rich tapestry. Look at the flowers of this wild poppy, which are newly blown: observe that they are sloped here and there. Compare them' with the tapestry whose tissue you are desirous of knowing, you can find no difference between them: this tapestry is no other than the fragments of the flowers of the wild poppy; and that is the secret origin of those slopings you remark on the poppies that border upon the nest. Your curiosity is not yet satisfied; you are desirous of ob serving a little the labour of our skilful worker in tapestry. The hole which she digs perpendicularly into the earth, is about three inches in depth. It is exactly cylindrical, as far as to seven or eight lines of the bottom. There it begins to open wider, which it does more and more. When the bee has made an end of giving it the suitable proportions, she proceeds to line it with the tapestry. With this view, she applies herself to cutting, with abundance of art, pieces of petals, of an oval form, from the flowers of the wild poppy, which she seizes with her legs, and conveys into her hole. These little scraps of tapestry, when transported thither, are very much crumbled; but the tapestry-bee knows how to spread them out, display them, and affix

them to the walls with astonishing art.

She applies at least two layers of the petals. She spreads two tapestries on each other. The reason of her furnishing herself with it from the flowers of the wild poppy, rather than from those of many other plants, is, because in them are united, to a higher degree, all those qualities which are requisite for the use to which the bee designs to put them. When the pieces which the bee has cut and transported are found to be too large for the place they are intended to occupy, she cuts off the superfluous parts of them, and conveys the shreds out of the apartment.

After hanging the tapestry, the bee fills the nest with paste, to the height of seven or eight lines. This is all that is necessary for the nourishment of the worm. The tapestry is designed to prevent the mixture of particles of earth with the paste.

You expect undoubtedly that the prudent bee should not fail to close up effectually the aperture of the nest, in order to hinder the access of those insects into it that are fond of the paste : this she takes proper care to do: and it is utterly impossible for you to discover, from the surface of the ground, the spot where the nest was, whose construction you have just been contemplating, such is the skill employed by the bee in closing it. This little white pebble was at the edge of the hole, or very near it; it has not changed its place, and indicates to us the part beneath which the nest is we are searching for. It seems then as if we should have nothing more to do than to raise up a light layer of earth, in order to expose to view the entrance of the bole, which has been so well close. Nothing can be easier or less doubtful. How great is your surprise! you have already taken up two or three inches of the earth in depth, and you cannot find the least appearance either of the hole or the tapestry. What can this mean What is become of the nest that was so skillfully constructed, so properly lined, and was upwards of three inches deep A few hours since, you admired the ingenious contrivance of' it, and now the whole has disappeared, so that you cannot discover the least trace of it. What mystery then is this! It is effected as follows:

* This is the name given by botanists to the leaves of flowers When the bee has done laying, and amassed her quantity of paste, she takes down the tapestry, folds it over the paste, which she wraps together in it pretty nearly as we fold on itself a coffin of paper that is half full. The egg and paste are by this means enclosed within a little bag of flowers. The bee has then nothing farther to do, but to fill up with earth all the void space that is above the bag; and this she performs with such wonderful activity and exactness, as utterly to conceal the place where the nest was.

If a hare does not possess, like the rabbit, the art of digging for himself a burrow, he does not however want a sufficient degree of sagacity to enable him to secure himself, and escape from his enemies. He can choose for himself a form, and conceal himself betwixt clods of earth that resemble the colour of his hair. In winter, he takes up his lodging to the south, and in summer time to the north ; when started by the dogs, he pursues the same track for some time, goes the same way back again, darts aside, throws himself into a bush, and there squats down. The pack follow the path, pass before the hare, and lose scent of him. The crafty animal sees them pass by and run far from him, he issues from his retreat, confounds his course, and puts the hounds to a loss. He varies his shifts continually, and always conducts them as his circumstances require. Sometimes at the cry of the bounds, he quits his form, speeds away to the distance of a quarter of a league, casts himself into a pond, and lies hid among the rushes, At others he mingles with a flock of sheep, and will not abandon them. One time he conceals himself under ground: at another,

leaps under a ruinous wall, crouches among the ivy, and lets the dogs pass him. Oftentimes he runs along one side of a hedge, whilst the dogs go on the other. Sometimes by several efforts he swims across a river. Lastly, at others, be obliges another hare to quit the form, in order to supply his place, &c. The stag, which by the elegance and lightness of his make, by those living branches, with which the head is rather adorned than armed. his size, strength and noble air, is one of the grand ornaments of the forest, is endued with more subtlety than even the bare, and more exercise for the sagacity of the huntsman. When pursued by the hounds, he passes and repasses several times on his track; eludes their pursuit by assorting himself with other beasts, darts forward, and immediately flees to a distance, darts aside: and steals away, and lies prostrate on his belly. The land betraying him everywhere, he betakes himself to the water. The hind the nourishes her young, presents herself to the dogs, in order to facilitate the escape of her young; she runs away with swiftness, and afterward returns to it.

32. The fox, celebrated for his subtlety, is no less circumspect than skilful, no less vigilant than crafty, he weighs cautiously the least of his measures, studies circumstances, watches incessantly, and always some contrivance in reserve to assist him upon an exigency. His genius so fruitful in resources, multiplies almost to infinity his shifts and stratagems.

Though extremely fleet in running, he does not trust to his natural swiftness: he judges that that alone would not be sufficient for his preservation. He works for himself, a timely asylum under ground; where he takes refuge in case of necessity, and lodges and brings up his family.

He establishes his dwelling-place on the border of woods, and in the neighbourhood of farm-houses. He listens afar off with an attentive ear to the cackling of poultry, directs his steps accordingly, arrives by several winding ways, squats himself down, passes along on his belly, lies in ambuscade, and rarely fails in his attempt.

If he is so happy as to penetrate into the enclosure, he employs to good purpose every moment of his time, and slaughters the whole stock. He immediately retreats, carries away with him one of the prey, conceals it, returns in search of another, hides that like the former, and does not cease from plundering till he perceives he has been discovered.

He is amazingly skilful in hunting young leverets, surprising the hares when lying down; in discovering the nest of partridges, or quails, and seizing the mother on her eggs.

Equally bold as crafty, he has even the courage to attack bees; he attempts to get their honey, which he is very fond of. These warlike insects presently assail him on all sides, and in a few moments he is entirely covered with them. He retires some paces, rolls himself on the ground, crushes them by that means, returns to the charge, and at length obliges this little laborious people to abandon to him the fruits of their long labours.

I shall add but one more instance; if the fox discovers that his young have been disturbed during his absence, he transports them, one after another, to a new place of retreat,

CONCLUSION

Here I set bounds to my design. I have presented my readers with a variety of facts of an interesting nature, sufficient to enable them to form an idea of those pleasures which result from the contemplation of nature. But this contemplation would prove fruitless, did it not lead us to

aspire incessantly after this adorable Being, by endeavouring to acquire a knowledge of him from that immense chain of various productions wherein his power and wisdom are displayed with such distinguished lustre. He does not impart to us the knowledge of himself immediately; that is not the plan he has chosen ; but he has commanded the heavens and the earth to proclaim his existence, to make him known to us. He has endued us with faculties susceptible of this divine language, and has raised up men who explore their beauties, and become their interpreters. Imprisoned for a while in a email obscure planet, we only enjoy such a portion of light as is suitable to our present condition: let us wisely improve each glimmering ray reflected upon us, nor lose the smallest spark: let us continually advance in this effulgent light! A time will come, when we shall draw all light from the Eternal Source of light, and instead of contemplating the Divine Architect in the works of his hands, shall contemplate the workmanship in the Omnipotent Author thereof. “We now see things as through a glass, darkly; but we shall see then face to face."