ANNIVERSARY ORATION,

DELIVERED MARCH 8, 1808,

BEFORE

The Medical Society of London,

ON THE

GENERAL STRUCTURE AND PHYSIOLOGY

OF

PLANTS,

COMPARED WITH THOSE OF

ANIMALS,

AND

THE MUTUAL CONVERTIBILITY OF THEIR ORGANIC ELEMENTS.

PUBLISHED AT THE UNANIMOUS REQUEST OF THE SOCIETY.

BY JOHN MASON GOOD, F. R. S.
Senior Secretary to the Medical Society.

Ουτω δ' ωοτοκει μακρα δενδρεα πρωτον ελαιας.

Empedocles.

So plants, like animals, uprise to air,
And in green eggs young olives olives bear.

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TO

THE PRESIDENT, COUNCIL, AND FELLOWS

OF

The Medical Society of London.

GENTLEMEN,

DULY sensible of the honour of your request, I hasten to comply with it; and readily consent that, under your patronage, the following Oration should aspire to a life in some degree less fugitive than it was originally intended for. Had I, indeed, designed it for publication, I should certainly have given it an arrangement in some measure different from what it possesses at present. But I do not now feel myself at liberty to make a change in this or any other respect; and have, hence, endeavoured to present you not only with the general train of argument, but with the language employed on the occasion as far as I have been able to recall it; and am,

Gentlemen,

your very obedient and faithful servant,

Caroline-Place,
April 2, 1808.

JOHN MASON GOOD.

Lately published by the same AUTHOR:

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9. SECOND ADDRESS to the MEMBERS of the CORPORATION of SURGEONS of LONDON. Published by Request of the Committee of the Corporation, 1799.

ANNIVERSARY ORATION,

DELIVERED BEFORE

The Medical Society of London.

THE subject, gentlemen, to which I have now the honour of inviting your attention, is a brief survey of the general structure and physiology of plants compared with those of animals, the conversion of vegetables into animal matter, and their reproduction from animal molecules. And in doing this, I am much afraid I shall have to draw very largely upon your candour, in consequence of my having had not many days to prepare myself for this purpose. The gentleman who was elected last March to deliver the anniversary oration of to day has, unfortunately, indeed, for all of us, thought proper to exercise his option of declining it; yet, owing to a mistake which it is needless to detail at present, no official notice of his having declined it reached the council of the Medical Society till a week or two ago, in consequence of which there appeared a strong chance that this part of our anniversary duty would remain unfulfilled. It was suggested to me, upon that occasion, that an offer of my humble services would be received not unkindly. I complied with the suggestion; the offer was accepted; and I now throw myself upon your indulgence for merely filling up a post, and at too short a notice, which, perhaps, would not otherwise have been filled up by any one.

AMIDST the maxims of an almost universal application, to be met with in the writings both of Harvey and Linnéus, the following is one of the most prominent, *Omne vivum ex ovo**. It is indeed the very basis of the sexual system, it has been propounded in every agé in which such a system has been

* By Harvey, however, this maxim was employed in reference to a particular theory, that of *female evolution:* it is here advanced upon a much more extensive scale, and supposed to apply equally to the theory of male or female evolution, or to that which is common to both, and has been denominated *epigenesis*. For a particular account of which different theories, see my translation of Lucretius, vol. ii. note on b. iv. v. 1264.

taught*, and is altogether as applicable to plants as to animals. For although in both we meet with occasional instances of propagation by other means, by buds and bulbs, by slips and cuttings, the exceptions are either so few or so irrelevant as rather to confirm the general rule than to subvert it, and to evince a double or triple mode of increase than to oppose the generation of eggs as the common mode.

The egg of the plant is its seed. The seed is sometimes naked, but more generally covered with a pericarp, whence plants become naturally divided into the two grand classes of gymnospermous, and angiospermous. The pericarp is of various forms and structures; and of these the more common are the legume, silique, or silicle, being merely varieties of what, among ourselves, is denominated in popular language cod or pod; the loment, which is a kind of pod not so frequent as either of the former, but of which

* See the very curious fragment of Empedocles, introduced as a motto to the title-page: upon which Aristotle remarks Το, τε γαρ ωον κυημα εστι, και εκ τινος αυτου γιγνεται το ζωον :—de Generat. Animal. i. 23. "For the egg is the conception, from which also the animal is created."

we have an instance in a plant well known to most of us, the *cassia fistula* of Linnéus, or the *cassia fistularis* of the dispensatories; the pome or core-apple, of which we have instances in the common-apple, and the orange; the drupe, or stone-apple, instances of which occur to us in the plum, cherry, and almond; the glume or chaff; the berry; the *acinus* or conglomerate berry as in the rasp; the nut; and the capsule.

Stripping off this outer covering, we find the seed to consist internally of a *corculum*, corcle*, or little heart, and externally of a parenchymatous substance surrounded with a double integument, sometimes single, sometimes bifid, and sometimes more than bifid; and hence denominated monocotyledonous, dicotyledonous, polycotyledonous. It was very generally supposed formerly, and is still supposed by some botanists, that the seeds of various orders of plants, as the mosses, fungi, and algæ, are acotyledonous, or totally destitute of a cotyledon of any kind. But as many, perhaps most plants of this kind have of late been discovered to

* Perhaps *heartlet* would be a better term than *corcle*, as more agreeable to the genius of our own language.

possess some such parenchyma, we have great reason to believe that this organ is universal, and that there is no such thing as an acotyledonous seed in the whole vegetable kingdom. In reality the cotyledon appears absolutely necessary for the germination and future growth of the seed, and may hence be denominated its lungs or placentule. Like the perfect plant, it possesses lymphatics and air-vessels. Through the former of these it absorbs the moisture of the soil into which it is plunged, decomposes a part of it into its elementary principles, and conducts those principles together with the undecomposed water to the corcle, which becomes stimulated to the process of germination by the oxygen thus set at liberty; while through the latter it breathes forth its excess of oxygen, together with a considerable portion of carbonic acid, and hydrogen gasses, and generally some portion of azot.

It is the corcle, then, which is the true *punctum saliens* of vegetable life, and to this the cotyledon is subservient. The corcle consists of two parts, an ascending and a descending; the former called its plumule, which gives birth to the trunk and branches, the latter, denominated its rostel, which gives birth to the root and radicles. The position of the corcle in the seed is always in the vicinity of the *hilum* or eye, which is a cicatrix or umbilicus remaining after the separation of the *funis* or umbilical cord from the pericarp to which the seed has hereby been attached. The first radicle or germinating branch of the rostel uniformly elongates, and pushes into the earth, before the plumule evinces any change: like the cotyledon, the radicles consist chiefly of lymphatics and air-vessels, which serve to separate the water from the soil, in order that the oxygen may be separated from the water.

Hence originates the root, unquestionably the most important part of the plant, and which in some sense may be regarded as the plant itself: for if every other part of the plant be destroyed, and the root remain uninjured, this organ will regerminate and the whole plant be renewed; but if the root perish, the plant becomes lost irrecoverably. Yet there are various phænomena in vegetable life that manifest a smaller difference in the nature of the root and the trunk, than we should at first be induced to suppose; for in several species, and especially those of the prunus and salix tribes*, if the stem branches be bent down to the earth, plunged into it, and continued in this situation for a few months, these branches will throw forth radicles; and if, after this, the original root be dug up, and suffered to ascend into the air, so that the whole plant become completely inverted, the original root will throw forth stem-branches and bear the wild fruit peculiar to its tribe. The *rhizophora*, mangle or mangrove-tree, grows naturally in this manner; for its stem-branches, having reached a certain perpendicular height, bend downwards of their own accord, and throw forth root-branches into the soil, from which new trunks arise, so that it is not uncommon, in some parts of Asia and Africa, to meet with a single tree of this species covering the oozy waters in which it grows, with a forest of half a mile in length.

The solid parts of the trunk of the plant consist of *cortex*, cuticle, or outer bark, *liber*,

* Plum or cherry, and willow or osier.

cutis, or inner bark, *alburnum*, or soft wood, *lignum*, or hard wood, and *medulla*, or pith. Linnéus gave the name of medulla to the pith of plants, upon a supposition that it had a near resemblance to the *medulla spinalis* of quadrupeds. A closer investigation, however, has since proved that this resemblance is very faint, and that the pith or medulla of vegetables consists of nothing more than a mere spongy cellular substance, forming indeed an admirable reservoir for moisture; and hence of the utmost importance to young plants, which, in consequence of their want of leaves and branches whose surfaces are covered with the bibulous mouths of innumerable lymphatics, would otherwise be frequently in danger of perishing through absolute drought; but gradually of less use as the plant advances in age, and becomes possest of these ornamental appendages; and hence, except in a few instances, annually encroached upon, and at length totally obliterated by the surrounding lignum.

All these lie in concentric circles; and the trunk enlarges, by the formation of a new liber or inner bark every year; the whole of the liber of one year, excepting indeed its outermost layer which is transformed into cortex, becoming the alburnum of the next, and the alburnum becoming the lignum. Whence it is obvious that a mark of any kind, which has penetrated through the outer into the inner bark, must in a long process of years be comparatively transferred to the central parts of the trunk; on which account we often find in felling trees of great longevity, as the oak, for example, the date of very remote national æras, and the initials of monarchs, who flourished in very early periods of our national history, stamped in the very heart of the timber on its being subdivided.

As these series of concentric circles, moreover, produced by the growth of every year, are still visible after the conversion of every other part into lignum, or hard wood, we can trace the age of a tree, with a considerable degree of certainty, by allowing a year for every outer circle, and about two or three years for the complete lignification of the innermost *.

* The palms form an exception to this general rule, possessing neither proper bark, nor fascicles of vessels

Independently of these more solid parts of the trunk or stem, we generally meet with some portion of parenchyma and cellular substance, and always with the different systems of vegetable vessels disposed in one common and uniform arrangement. The lower orders of plants, indeed, such as the annuals and biennials, consist almost exclusively of parenchyma or cellular substance, with an inner and outer bark, and the respective vessels of the vegetable system.

These vessels are adducent and reducent or arteries and veins, pneumatic or air-vessels, and lymphatics. The lymphatics lie immediately under the cuticle and in the cuticle. They anastomose in different ways through their minute intermediate branches, and, by surrounding the apertures of the cuticle, perform the alternating economy of inhalation and exhalation. Their direction varies in different species of plants, but is always uniform in the same species.

displayed in any circular form: the bark being produced by a remnant of the leaves, and the vessels running in a straight line without regular order, and surrounded by cellular substance.

Immediately below these lie the adducent vessels or arteries; they are the largest of all the vegetable vessels, rise immediately from the root, and communicate nutriment in a perpendicular direction: and when the stem of a plant is cut horizontally they instantly appear in circles. Interior to these lie the reducent vessels or veins; which are softer, more numerous, and more minute than the arteries; and in young shoots run down through the cellular texture and the pith. Between the arteries and veins are situated the air-vessels; which are delicate membranous tubes stretching in a spiral direction, the folds being sometimes close to each other, and sometimes more distant, but generally growing thicker towards the root, and especially in ligneous plants. These vessels also are very minute, and according to numerous observations of Hedwig made with the microscope, seldom exceed a 290th part of a line, or a 3000th part of an inch in diameter.

The lymphatics of a plant may be often seen with great ease by merely stripping off the cuticle with a delicate hand, and then subjecting it to a microscope; and in the course of the examination we are also frequently able to trace the existence of a great multitude of valves, by the action of which the apertures of the lymphatics are commonly found closed. Whether the other systems of vegetable vessels possess the same mechanism, we have not been able to determine decisively; the following experiment, however, should induce us to conclude that they do. If we take the stem of a common balsamine*, or of various other plants, and cut it horizontally at its lower end, and plunge it, so cut, into a decoction of Brazil-wood, or any other coloured fluid, we shall perceive that the arteries or adducent vessels, as also the air-vessels, will become filled or injected by an absorption of the coloured liquor, but that the veins, or reducent vessels, will not become filled; of course evincing an obstacle, in this direction, to the ascent of the coloured fluid. But if we invert the stem, and in like manner cut horizontally the extremity which till now was uppermost, and plunge it so cut into the same fluid, we shall then perceive that the

* *Impatiens balsamina*:—This is the plant recommended by M. Willdenow for this purpose, as affording the clearest results.

veins will become injected, or suffer the fluid to ascend, but that the arteries will not: proving clearly the same kind of obstacle in the course of the arteries in this direction, which was proved to exist in the veins in the opposite direction; and which reverse obstacles we can scarcely ascribe to any other cause than the existence of valves.

By this double set of vessels, moreover, possest of an opposite power, and acting in an opposite direction, the one to convey the sap or vegetable blood forwards, and the other to bring it backwards, we are able very sufficiently to establish the phænomenon of a circulatory system: and, according to several of the experiments of M. Willdenow, it seems probable that this circulatory system is maintained by the projectile force of a regular and alternate contraction and dilatation of the vegetable vessels. Yet the great minuteness of these vessels must ever render it extremely difficult to obtain any thing like absolute certainty upon this subject. Even in the most perfectly established circulatory systems of animals, in man himself, it is not once in five hundred instances, that we are able to acquire any palpable proof of such a fact: we are positive of the existence of an alternating systole and diastole in the larger arteries, because their pulsation gives proof of it to the finger; but throughout all the minuter arteries, which are infinitely more numerous, we reason rather than perceive, we infer a similarity of action, because, from mere analogy, we ascribe a similarity of power. How much less, then, ought we to expect any full demonstration of this point in the vessels of vegetables, in every instance so much more minute than those of the more perfect animals, and seldom exceeding, as I have already observed, a three thousandth part of an inch in diameter!

It becomes me, however, to confess that no experiments which have hitherto been made have detected the existence of muscular or nervous fibres in vegetables, although very high degrees of galvanic electricity have for this purpose been applied to the most irritable of them, as the *dionæa muscipula*, or Venus-fly-trap; *oxalis sensitiva*; different species of *drosera*, or sun-dew; *acacias* of various kinds, and other *mimosas*; and especially the *mimosa pudica*, and *sensitiva*, the common sensitive plants of our green-houses. Humboldt has uniformly failed; Rafn appears to have succeeded in one or two instances, but his general want of success prevents us from being able to lay any weight on the single case or two in which he seems to have been more fortunate.

Yet, notwithstanding all that has been advanced, as to the necessity of a regular and alternate contraction and dilatation for the production of a circulatory system both in animals and vegetables, still must we admit the competency of other powers to produce the same result while we reflect on the facility with which the human *cutis* or skin, an organ destitute of all muscular fibres whatever, contracts and relaxes generally on the application of a variety of other powers; powers different in their nature, and in their effect palpable to the external senses: whilst we recal to mind that it is contracted by austere, and relaxed by oleaginous preparations; constringed by cold, and dilated by warmth: and that the opposite passions of the mind have a still more powerful influence on the same organ, since fear, apprehension, horror, will not only freeze and corrugate the *skin*, but, in the language of the poet, which is also the language of nature, freeze the *blood* itself, making

——each particular hair to stand on end
Like quills upon the fretful porcupine:

while hope, pleasure, agreeable expectation, smooth, soften, and expand it to an equal degree, and figuratively, perhaps literally, lubricate it with the *oil of joy*. More especially must we come to this conclusion, while in conjunction herewith, we survey, in various species of the vegetable kingdom, as strong a contractility and irritability as are to be met with in the most contractile and irritable muscles of the most sentient animals.

Yet could it even be proved that the vessels of plants are incapable of being made to contract by any power whatever, still should we have no great difficulty in conceiving a perfect circulatory system in animals or vegetables without any such cause, whilst we reflect that one half of the circulation of the blood in man himself is accomplished without such a contrivance; and this, too, the more difficult half, as every one knows that the veins have, for the most part, to oppose the attraction of gravitation, instead of being able to take advantage of it.

To argue, therefore, against the existence of a circulation of blood or sap in plants, from the single circumstance that we are not able to prove demonstrably their possession either of muscular fibres, or of a regular systole and diastole, is merely to argue *ex ignorantiâ*, and in defiance of facts and experiments which, if not absolutely decisive, are perhaps as decisive as the nature of the case will allow. We have, at this moment, nearly as much reason for believing in the circulation of the blood of vegetables, as we had in that of animals anterior to the confirmation of this important reality by the observations of the immortal Harvey.

In fine, the great mass of the facts and phænomena of vegetable life has so close a resemblance and parallelism to the facts and phænomena of animal life, if we except those which relate to the rational and immortal mind, with which I have no concern at present, as clearly to indicate the application of one common system to both, as far as one common system can be made to apply; and, if I mistake not, to demonstrate one common derivation from one common and almighty cause. And having thus far submitted to your attention a brief outline of the general structure of vegetables, I shall now proceed to point out a few of their resemblances to the œconomy or habits of animals, and shall endeavour to select those which are either most curious or most prominent.

Plants, then, like animals, are propagated by sexual connection. This, which, as an opinion, was entertained by Aristotle, and, as a doctrine studied and taught still earlier, by Empedocles and Theophrastus*, is in the present day a position incontrovertibly esta-

* That it was publicly taught by Empedocles is clear, not only from the verse of this excellent poet and philosopher preserved by Aristotle, and introduced as a motto to the title-page of this oration, but from a variety of other passages in the writings of Aristotle, in which he expressly tells us that Empedocles directed much of his attention to ascertain whether in plants the male were distinct from the female, or whether both sexes were united in the same individual; and that at last he inclined to the latter opinion, in which Aristotle himself appears to have followed him. Ὅπερ ειπεν ὁ Εμπεδοκλης, ηγουν ει ἑυρισκεται εν τοις φυτοις γενος θηλυ, και γενος αῤῥεν, και ει εστιν ειδος κεκραμενον εκ τουτων των δυο γενων.—Γενος εν τουτοις κεκραμενον ειναι. Aristot. de Plantis, l. i. c. 2. & l. i. c. 1.

Theophrastus advances further, and asserts that plants may admit of a division into many classes from their variety; but that the general distinction should be that of male and female; —παντων δε ὡσπερ ελεχθη, των δενδρων, ὡς blished by the discoveries of Zaluzianski, the still more accurate observations of Linnéus, and the concurrent labours of a host of later botanists who have pursued their footsteps. And although among vegetables we meet with a few instances of propagation by other means, as, for instance, by slips and offsets, or by buds and bulbs, the parallelism, instead of being hereby diminished, is only drawn the closer; for we meet with just as many instances of the same varieties of propagation among animals. Thus the hydra, or polype, as it is more generally called, the asterias, and several species of the leech, as the *hirudo viridis*, for example, are uniformly propagated by lateral sections, or instinctive slips or offsets*; while almost

καθ' ἑκαστον γενος λαϐειν, διαφοραι πλειους εισιν· η μεν κοινη πασιν, η διαιρουσι το θηλυ και το αῤῥεν. Theophr. Hist. Plant. l. iii. c. 9.

The authority of Claudian, in an exquisite passage too well known to be quoted, though of a much later date, is less to be depended upon; since it was unquestionably written under the influence of a strong poetic imagination, and is liable to the suspicion of imagination alone: a suspicion which cannot fall upon Empedocles, after the interpretation of Aristotle with respect to his philosophic opinions.

* So again Aristotle, upon a subject which is generally supposed to be of modern discovery, 'Ωσπερ γαρ τα φυτα,

every genus of zoophytic worms is only capable of increase by buds, bulbs, or knobs.

The blood of plants, like that of animals, instead of being simple is compound, and consists of a great multitude of compacter corpuscles, globules for the most part, but not always globules, floating in a looser and almost diaphanous fluid. From this common current of vitality, plants, like animals, secrete a variety of substances of different, and frequently of opposite powers and qualities,—substances nutritive, medicinal, or destructive. And as in animal life, so also in vegetable, it is often observed that the very same tribe, or even individual, that in some of its organs secretes a wholesome aliment, in other organs secretes a deadly poison. As the viper pours into the reservoir situated at the bottom of his hollow tusk a fluid fatal to other animals, while in the general substance of his body he offers us not only a healthful nutriment, but, in

και ταυτα (scilicet *εντιμα*) *διαιϱουμενα δυναται ζην*. Hist. Anim. l. iv. c. 6. "For, like plants, such insects also maintain life, after slips or cuttings."

See a variety of other curious instances in the translation of Lucretius by the author of this oration, note to b. ii. ver. 880.

some sort, an antidote for the venom of his jaw: so the *jatropha manihot*, or Indian cassava, secretes a juice extremely poisonous in its root, while its leaves are regarded as a common esculent in the country, and are eaten like spinach-leaves among ourselves.

In like manner the *amyris*, in one of its species offers the balm-of-Gilead tree, in another the gum-elemi tree, and in a third * the poison-ash. It is from a fourth species of this genus, I will just observe as I pass along, in order the more completely to familiarize it to us, that we obtain that beautiful plant which, under the name of rose-wood †, is now so great a favourite in our drawing-rooms.

The *mimosa nilotica*, or gum-Arabic tree, is a rich instance in proof of the same observation. Its root throws forth a fluid that smells as offensively as asafœtida; the juice of its stem is severely sour and astringent; the secernents of its cutis exude a sweet, saccharine, nutritive gum, the common gum-Arabic of the shops, and its flowers diffuse a highly fragrant and regaling odour.

* *A. toxifera.* † *A. balsamifera.*

But perhaps the *laurus*, as a genus, offers us the most extensive variety of substances of different qualities. This elegant plant, in one of its species gives us the cinnamon-tree *; in another, the cassia, or wild cinnamon †; in a third, the camphor-tree ‡; in a fourth, the alligator-pear §; in a fifth, the sassafras ‖; in a sixth, a sort of gum-Benjamin ¶, though not the real gum-Benjamin, which is a *styrax*; while in a seventh, the *L. caustica*, it exhibits a tree with a sap as poisonous as that of the manchineel.

And truly extraordinary is it, and highly worthy of notice, that various plants or juices of plants, which are fatally poisonous to some animals, may not only be eaten with impunity by others, but will afford them a sound and wholesome nutriment. How numerous are the insect tribes that feed and fatten on all the species of *euphorbia*, or noxious spurge! The *dhanesa*, or Indian buceros, feeds to excess on the *colubrina* or *nux vomica*; and the land-crab ⍭ on the

* *L. Cinnamomum.* † *L. Cassia.* ‡ *L. Camphora.*
§ *L. Persea.* ‖ *L. Sassafras.* ¶ *L. Benzoin.*
⍭ *Cancer ruricola.*

berries of the *hippomane* or manchineel-tree. The leaves of the *kalmia latifolia* are feasted upon by the deer, and the round-horned elk*, but are mortally poisonous to sheep, to horned cattle, to horses, and to man. The bee extracts honey without injury from its nectary, but the man who partakes of that honey after it is deposited in the hive-cells falls a victim to his repast. Some very singular cases in proof of this assertion occurred at Philadelphia no longer ago than the year 1790, in the autumn and winter of which an extensive mortality was produced amongst those who had partaken of the honey that had been collected in the neighbourhood of Philadelphia, or had feasted on the common American pheasant, or pinnated grous † as we call it in our own country. The attention of the American government was excited by the general distress, a minute examination into the cause of the mortality ensued, and it was satisfactorily ascertained that the honey had been chiefly extracted from the flowers of the *kalmia latifolia*, and that the pheasants which had proved thus poisonous had fed harmlessly

* *Cervus wapiti* of Barton. † *Tetrao cupido.*

on its leaves. In consequence of which a public proclamation was issued, prohibiting the use of the pheasant, as a food, for that season. The account is given in detail in the fifth volume of the American Philosophical Transactions, by that very accurate and excellent physiologist Dr. Barton, president of the American Linnéan Society, and professor of medicine in the university of Philadelphia; to whom I beg leave thus publicly to return my very sincere thanks for some very valuable physiological observations he has lately transmitted to me, and the rather because I see before me a learned correspondent and friend of the professor's, who will not suffer this public testimony of my gratitude to pass unnoticed.

So differently constituted are the digestive powers of some animals compared with those of others; and so true is the observation of the first poet and natural philosopher of ancient Rome, an observation, too, made in the contemplation of this very fact,—

Tantaque in hiis rebus distantia, differitasque est,
Ut quod aliis cibus est, aliis fuat acre venenum *.

Animals, as we all know, are liable to a

* Lucret. iv. 540. In the note upon the translation

great variety of diseases; so, too, are vegetables; to diseases as numerous, as varied, and as fatal; to diseases epidemic, endemic, sporadic; to scabies, pernio, ulcer, gangrene; to polysarcia, atrophy, and, above all, to invermination. Whatever, in fine, be the system of nosology to which we are attached, to Sauvage's, Vogel's, or Cullen's, it is impossible for us to put our hand upon any one class or order of diseases which they describe, without putting our hand, at the same time, upon some disease to which plants are subject in common with animals. A simple, succinct, and perspicuous vegetable nosology would, indeed, be a production of no small value to the world. M. Willdenow has done much towards putting us into possession of such a treasure; let us hope that some future phytologist will complete what he has so admirably essayed, or that this excellent naturalist may yet live to give perfection to his own labours.

There are some tribes of animals that exfoliate their cuticle annually, such are grasshoppers, spiders, several species of crabs, and

of which already referred to, the reader will find a variety of other curious instances on the same subject.

serpents. Among vegetables we meet with a similar variation from the common rule, in the shrubby cinquefoil *, indigenous to Yorkshire, and the plane-tree of the West-Indies †.

Animals are occasionally divided into the two classes of locomotive or migratory, and fixed or permanent; vegetables may partake of a similar classification. Unquestionably the greater number of animals are of the former section, yet in every order of worms we meet with some instances that naturally appertain to the latter, while almost every genus and species of the zoophytic order, its millepores, madrepores, tubipores, gorgonias, isises, corallines, and sponges can only be included under it. Plants, on the contrary, are for the most part stationary, yet there are many that are fairly entitled to be regarded as locomotive or migratory. The natural order *senticosæ*, the *icosandria polygynia* of the sexual system, offers us a variety of instances, of which the *fragaria* or strawberry may be selected as a familiar example. The palmate, the testicular, and the premorse rooted afford

* *Potentilla fruticosa.* † *Platanus occidentalis.*

us similar proofs:—many of these grow from a new bulb, or knob, or radicle, while the old root, of whatever description it may be, dies away; in consequence of which, we can only conclude that the vital principle of the plant has quitted an old, dilapidated, and ruinous mansion, to take possession of a new one. Insomuch that were a person, on the point of travelling to the East Indies, to plant the root of an orchis*, or a scabious†, in a particular spot in his garden, and to search for it in the same spot on his return home, he would be in no small degree disappointed; and if he were to remain abroad long, he must carry his pursuit to half an acre's distance, for thus far would some of these roots perhaps have travelled in a few years.

Plants, like animals, have a wonderful power of maintaining their common temperature, whatever be the temperature of the atmosphere that surrounds them; and hence occasionally of raising the thermometer, and occasionally of depressing it. Like animals,

* *Orchis morio*, or *latifolia*.

† *Scabiosa succisa*, or devil's bit.

too, they are found to exist in most astonishing degrees of heat and cold, and to accommodate themselves accordingly. Wherever the interest or curiosity of man has led him into climates of the highest northern latitudes; wherever he has been able to exist himself, or to trace a vestige of animal being around him; there, too, has he beheld plants of an exquisite beauty and perfection; perfuming, perhaps, in many instances, the dead and silent atmosphere with their fragrances, and embellishing the barren scenery with their corols.

It is said that animals of a certain character, the cold-blooded and amphibious, have a stronger tenacity to life than vegetables of any kind. But the assertion seems to have been hazarded too precipitately; for, admitting that the common water newt * has been occasionally found imbedded in large masses of ice, perfectly torpid and apparently frozen; and that the common eel †, when equally frozen and torpefied, is capable of being conveyed a thousand miles up the country, as from St. Petersburg, for

* *Lacerta aquatica.* † *Muræna Anguilla.*

example, to Moscow, in which country, we are told, it is a common practice thus to convey it; and that both, on being carefully thawed, may be restored to as full a possession of health and activity as ever; yet the torpidity hereby induced can only be compared to that of deciduous plants in the winter months; during which season we all know that, if proper care be exercised, they may be removed to any distance whatever without the smallest inconvenience *.

Plants, again, are capable of existing in very high degrees of heat. M. Sonnerat found the *vitex agnus castus*, and two species of *aspalathus*, on the banks of a thermal rivulet

* Severe cold produces a general torpidity in all animals, and often, even in those of the highest natural orders, a torpidity short of death; during which state there is so little exhaustion taking place, that the animal is capable of existing for weeks or months without any supply of food. We see this annually in the hybernal sleep of birds, reptiles, and insects, and we have had occasional instances of it in mankind. Such was that of the farmer's wife, who, a few years ago, was dug out of high drifts of snow near Cambridge, after having been buried there, and without food, for eleven or twelve days. See this fact more fully accounted for, and other instances adduced, in the note upon Lucretius as above, b. iv. ver. 1006.

in the island of Lucon, the heat of which raised the thermometer to 174° of Fahrenheit, and so near the water that its roots swept into it. Around the borders of a volcano in the isle of Tanna, where the thermometer stood at 210°, Mr. Forster found a variety of flowers flourishing in the highest state of perfection; and confervas and other water-plants are by no means unfrequently traced in the boiling springs of Italy, raising the thermometer to 212° or the boiling point.

Animals are capable of enduring a heat quite as extreme. Air has often been breathed by the human species with impunity at 264°. Tillet mentions its having been respired at 300°; and Morantin, one instance, at 325°, and that for the space of five minutes. Sonnerat found fishes existing in a hot spring at the Manillas at 158°*: and M. Humboldt and M. Bonpland, in travelling through the province of Quito in South America, perceived other fishes thrown up alive and apparently in health from the bottom of a volcano, in the course of its explosions, along

* He graduates by Reaumur's thermometer, and calculates the heat upon this at 69°.

with water and heated vapour that raised the thermometer to 210°, being only two degrees short of the boiling point *. This last assertion has been discredited by some naturalists in our own country, but I think too hastily; and I am happy to have it in my power, on this occasion, to add in no small degree to the testimony of these enterprising and very observant travellers. The manuscript now in my hands is an autographic note, written by the late lord Bute, himself an excellent zoologist, to his friend the late reverend William Jones of Nayland in Suffolk, as justly celebrated for his philosophical as for his theological publications, and was communicated to me by Edward Walker, esquire, of Gestingthorpe, Essex, (who married Mr. Jones's only daughter,) a gentleman who is himself well versed in botanical science. In this note, after deservedly complimenting Mr. Jones on a philosophical work he had just produced, his noble correspondent adds, "Lord Bute cannot help imparting to Mr. Jones a singular observation made by him

* Recueil d' Observations de Zoologie et d'Anatomie comparée.

in June last, at the baths of Abano near the Euganian mountains in the borders of the Paduan state, famous in ancient authors: they are strong sulphur boiling springs, oozing out of a rocky eminence in great numbers, spreading over an acre of the top of a gentle hill. In the midst of these boiling springs, within three feet of five or six of them, rises a tepid one, about blood-warm, the only source used for drinking: but the extraordinary circumstance is, that not only confervas, &c. were found in the *boiling springs*, but numbers of small black beetles that died on being taken out, and plunged into cold waters. How amazingly must the great Author of nature have formed these creatures to bear a *constant heat* of above 200° !"

I take it for granted that the animals here referred to were not species of the *scarabæus* or genuine beetle, which is not a water-insect, but of the *dytiscus* or *hydrophil* which are so, and which have so near a resemblance to the scarabæus, as to be denominated water-beetles by many zoologists. And upon this explanation suffer me to observe, that it is impossible for any collusion to have taken place between these different witnesses, unconnected in every respect as they must have been with each other, living at different periods, and travelling to different quarters of the globe; and that hence, in the opinion of every man of candour, the testimony of the one cannot fail in a very considerable degree to establish the testimony of the other.

In reality, without wandering from our own country we may at times meet with a variety of other phænomena perfectly consonant in their nature, and altogether as extraordinary and anomalous, if we only attend to them as they rise before us. Thus the eggs of the *musca vomitoria*, our common flesh-fly, or blow-fly, are often deposited in the heat of summer upon putrescent meat, and broiled with such meat over a gridiron in the form of steaks, in a heat not merely of 212°, but of three or four times 212°. And yet, instead of being hereby destroyed, we sometimes find them quickened by this very exposure into their larva or grub state. And although I am ready to allow that, in the simple form of seeds or eggs, plants or animals may be expected to sustain a far higher degree of heat or cold with impunity, than in their subsequent and more perfect state; yet it cannot appear more extraordinary that in such perfect state they should be able to resist a heat of 210° or 212°, than that in the state of seeds or eggs they should be able to exist in, and to derive benefit from, a heat three or four times as excessive.

In the vegetable world we meet with phænomena quite as anomalous. Thus, the *byssus asbestos* (an *alga* whose specific name explains the peculiarity of its properties) is altogether incombustible. Throw this plant into the fire, and instead of burning it becomes instantaneously converted into glass. So among the mosses, the *fontinalis antipyretica* (thus specifically denominated for the very same reason) is nearly as incombustible. This moss is indigenous to the Highlands, but is found still more generally in Scandinavia; and in this last country, the lower orders of the inhabitants, on account of its extreme inaptitude to burn, collect it as a lining for their chimneys to prevent them from catching fire.

Animals are often divided into the three classes of terrestrial, aquatic, and aërial.

Plants are capable of a similar division. Among animals it is probable that the largest number consists of the first class; yet from the great variety of submarine genera that are known, and from nearly an equal variety perhaps that are not known, this is uncertain. Amongst vegetables, however, it is highly probable that the largest number belongs to the submarine class, if we may judge from the almost countless species of *fuci* and other equally prolific tribes of an aqueous and subaqueous origin, and the incalculable individuals that appertain to each species; and more especially if we take into consideration the greater equality of temperature which must necessarily exist in the submarine hills and valleys.

Many animals are amphibious, or capable of preserving life in either element; the vegetable world is not without instances of a similar power. The *algæ*, and especially in the *ulva* and *fucus* tribes, offer us a multitude of examples. The *juncus*, in many of its species, is an amphibious plant; so too is the *oryza*. In other words, all will flourish entirely covered with water, or with their roots alone shooting into a moist soil.

Animals of various kinds are aërial: perhaps the term is not used with strict correctness. It will, at least, apply with more correctness to plants. All the most succulent plants of hot climates are of this description: such are several of the palms and of the cannas; and the greater number of plants that embellish the arid Karro fields of the Cape of Good Hope*. Succulent as they are, these will only grow in soils or sands so sere and adust that no moisture can be extracted from them, and are even destroyed by a full supply of wet or by a rainy season. And hence it is an opinion common to many of the ablest physiologists of the present day, that they derive the whole of their nutriment from the surrounding atmosphere; and that the only advantage which they acquire from thrusting their roots into such strata is that of obtaining an erect position. There are some quadrupeds that appear to derive nutriment in the same manner. Thus the *bradypus*, or sloth, never drinks, and trembles at the feeling of rain; while the

* The only rain that waters this tract is that which falls for a few weeks in the winter; during the hot and fertile months there is no rain whatever.

olive cavy * avoids water of every kind almost as pertinaciously, and yet these are animals almost as succulent as any we are acquainted with.

But however true this may be with regard to animals, we have palpable proofs that vegetables of certain tribes and descriptions are altogether supported by the atmosphere that surrounds them; for, important as is the organ of a root to plants in general, there are several which have no root whatever, and can derive nutriment in no other way. The water-caltrop † is an instance directly in point. The seed of this plant has no rostel, and consequently can never, in the first instance, become rooted. From the horned nut or pericarp of the seed, as it lies in water, which is its natural element, shoots forth a long plumule perpendicularly towards the surface of the stream; during the ascent of which a variety of capillary, branched leaves shoot forth from the sides

* *Cavia Acuschy*. This is the more extraordinary, because the *C. Cobaya*, or Guinea pig, drinks freely; and the *C. Capybara*, or river cavy, is fond of swimming and diving.

† *Trapa natans*.

of the plumule, some of which bend downward, and fix the whole plant to the bottom by penetrating into the soil below the stream; the leaves alone in this late stage of germination acting the part of a root, and giving maturity to the still unfinished plant. The *cactus* genus in some of its very numerous species offers us an example of similar evolution; and especially in the *opuntia* tribe, or that which embraces the prickly pears or Indian figs of our green-houses, of which the cochineal plant * is an individual. Of these, several grow by the mere introduction of one of their thick fleshy leaves into a soil of almost any kind that is sufficiently dry; they obtain an erect position, but never root, or shoot forth radicles: and hence almost the whole of their moisture must necessarily be derived from the surrounding atmosphere.

Perhaps one half of the *fuci* have no root whatever: many of them, indeed, consist of vesicles or vesicular bulbs alone, sessile upon the matrix of stone or shell that supports them, and propagate their kinds by

* *Cactus coccinellifer.*

offsets, without any other vegetable organs.

The *aphyteia* * is a curious instance in point. This plant is equally destitute of leaves, stem, and root; and consists alone of a sessile, coriaceous, and succulent flower, eaten as a luxury by the Hottentots, and parasitic to the roots of the *euphorbia Mauritanica*; flower propagating flower from generation to generation.

But perhaps the plant most decisive upon this subject is the aërial *epidendrum* †, first, if I mistake not, described by that excellent Portuguese phytologist Loureiro, and denominated *aërial* from its very extraordinary properties. This is a native of Java and the East Indies beyond the Ganges; and, in the latter region, it is no uncommon thing for the inhabitants to pluck it up on account of the elegance of its leaves, the beauty of its flower, and the exquisite odour it diffuses, and to suspend it by a silken cord from the ceilings of their rooms; where, from year to year, it continues to put forth new leaves, new blossoms, and new fragrance, excited

* *Monadelphia triandria.* † *Epidendrum flos aëris.*

alone to new life and action by the stimulus of the surrounding atmosphere.

That stimulus is oxygen; ammonia is a good stimulus, but oxygen possesses far superior powers, and hence without some portion of oxygen no plant can ever be made to germinate: hence too the use of cow-dung and other animal recrements, which consist of muriatic acid and ammonia, while in fat oil and other fluids that contain little or no oxygen, and consist altogether or nearly so of hydrogen and carbon, seeds may be confined for ages without exhibiting any germination whatever. And hence, again, and the fact deserves to be extensively known, however torpid a seed may be, and destitute of all power to vegetate in any other substance, if steeped in a diluted solution of oxygenated muriatic acid, at a temperature of about 46° or 48° of Fahrenheit, provided it still possess its principle of vitality, it will germinate in a few hours; and if, after this, it be planted, as it ought to be, in its appropriate soil, will grow with as much speed and vigour as if it had evinced no torpidity whatever.

Such, then, is a rapid sketch of several of the more curious or more prominent resemblances that exist in the physiology of animals and vegetables. Others, and in great numbers, might be adduced; but these I trust are sufficient. And it next becomes a question, not merely of curiosity but of high moment and importance, what is the mode by which vegetable matter, possessing these and other resemblances to animal matter, is capable of being converted into animal substance so as not only to be perfectly ASSIMILATED to it, but to become the basis of animal nutriment and increase?

Now to be able to reply succinctly and directly to this question, it is necessary first of all to inquire into the chief feature in which animal and vegetable substances agree, and the chief feature in which they disagree.

Animals and vegetables then agree in their equal necessity of extracting a certain sweet and saccharine fluid, as the basis of their support, from whatever substances may, for this purpose, be applied to their respective organs of digestion. Animal chyle and vegetable sap have a very close approximation to each other in their constituent principles; as well as in their external appearance. In this respect plants and animals agree. They disagree, inasmuch as animal substances possess a very large proportion of azot, with a very small proportion of carbon; while vegetable substances on the contrary possess a very large proportion of carbon, with a very small proportion of azot. And it is hence obvious that vegetable matter can only be assimilated to animal by parting with its excess of carbon, and filling up its deficiency of azot*.

Vegetable substances, then, part first of

* To Halle we are indebted for the outlines of this theory, which is founded upon the discoveries of Scheele, Bergman, Lavoisier and Priestley; and owes much of its support and confirmation to the observations as well as the discoveries of Berthollet. Compare Halle's "Essaie de Théorie sur l'Animalization et l'Assimilation des Alimens" in the Annales de Chimie, tom. ii. page 158, with Humboldt's "Versuch einer Physischen Darstellung der Lebenskrafte," in the Physiologie Animale, tom. xlviii.

In filling up this outline, however, M. Halle appears to have wandered rather too freely into the region of conjecture and mere speculation; and the system has, hence, been remodified by M. Fourcroy, and placed on a much firmer basis. It would occupy too much space to enter minutely into the difference between the two theories, and I must therefore refer the reader to the Encyclop. Method. tom. ii. art. Chimie; Paris, 1792.

all with a considerable portion of their excess of carbon, in the stomach and intestinal canal, during the process of digestion; a certain quantity of the carbon detaching a certain quantity of the oxygen existing in these organs, as an elementary part of the air or water they contain, in consequence of its closer affinity to oxygen, and producing carbonic acid gass; a fact which has been clearly ascertained by a variety of experiments by M. Jurine of Geneva *. A very large surplus of carbon, however, still enters the animal system through the medium of the lacteals, and continues to circulate with the chyle, or the blood, till it reaches the lungs. Here again a considerable portion of carbon is perpetually parted with upon every expiration, in the same form of carbonic gass, in consequence of its union with a part of the oxygen introduced into the lungs with every returning inspiration; as is sufficiently established by the experiments of Mr. Davy, and other celebrated chemists†;—

* Detailed by M. Halle in his Essay just referred to.

† See Mr. Davy's Researches Chemical and Philosophical, &c. and Mémoire sur la Chaleur, par M. M. Lavoisier et De la Place. Mem. de l'Acad. De la Combustion, &c.

while the excess, that yet remains, is carried off by the skin, in consequence of its contact with atmospheric air: a fact put beyond all doubt by the experiments and observations of M. Jurine, although, on a superficial view, opposed by a few experiments of Mr. Ingenhouz *; and obvious to every one from the well-known circumstance that the purest linen, upon the purest skin, in the purest atmosphere, soon becomes discoloured.

In this way, then, and by this triple cooperation of the stomach, the lungs, and the skin, vegetable matter, in its conversion into animal, parts with the whole of its excess of carbon.

Its deficiency of azot becomes supplied in a twofold method. First, at the lungs; also, by the process of respiration; for we uniformly find, and the experiments of Dr. Priestley and Mr. Davy † are fully conclusive upon this subject, that a larger portion

* Essaie de Théorie sur l'Animalization et l'Assimilation des Alimens, &c. Annales de Chimie, tom. ii.

† See Mr. Davy's Researches Chemical and Philosophical, &c. and Dr. Priestley's Experiments and Observations on different Kinds of Air. vol, iii.

of azot is inhaled upon every inspiration, than is returned by every succeeding expiration; in consequence of which the portion retained in the lungs must enter into the system, in the same manner as the retained oxygen, and perhaps in conjunction with it;—while, in unison with this action of the lungs, the skin also absorbs a considerable quantity of azot, and thus completes the supply that is necessary for the animalization of vegetable food *: evincing, hereby, a double consent of action in these two organs, and giving us some insight into the mode by which insects and worms, which are totally destitute of lungs, are capable of employing the skin as a substitute for lungs, by breathing through certain spiracles introduced into the skin for this purpose, or

* M. Jurine is chiefly entitled to the honour of this discovery; his experiments coincide with several of Dr. Priestley's results, and have been since confirmed by other experiments of M. M. Lavoisier and Fourcroy. See Premier Mémoire sur la Transpiration des Animaux, par A. Seguin et Lavoisier, 1792; and compare with M. Hassenfratz's Mémoire sur la Combinaison de l'Oxygene, &c. Acad. des Scien. 1791.

merely through the common pores of the skin, without any such additional mechanism. It is by this mode also that respiration takes place through the whole vegetable world, offering us another instance of resemblance to many parts of the animal; in consequence of which insects, worms, and the leaves of vegetables, equally perish, by being smeared over with oil, or any other viscous fluid that obstructs their cutaneous orifices.

But to complete the great circle of universal action, and to preserve the important balance of nature in a state of equipoise, it is necessary, also, to inquire by what means animal matter is reconverted into vegetable; so as to afford to plants the same basis of nutriment which plants have previously afforded to animals?

Now, this is, for the most part, obtained by the process of PUTREFACTION, or a return of the radical elements of animal matter to their original affinities, from which they have been inflected by the superior control of the vital principle, so long as it inhabited the animal frame, and coerced into other combinations and productions *. Putrefaction is, therefore, to be regarded as a very important link in the great chain of universal life and harmony.

The radical elements or primordia of animal matter are usually enumerated as follows: oxygen, azot or nitrogen, hydrogen, carbon; lime, iron, sulphur, soda and phosphorus. But as the last five are all compound substances, and the last four dissolve into their own *primordia* in the general dissolution of the animal frame, the only principles it is necessary to notice at present are the simple gasses of animal matter, and the mode of their separation.

Of these gasses I have already observed, that nitrogen is by far the largest in respect of quantity, and it appears also to be, by far, the most active. Hence, on the cessation of the vital principle, the azotic corpuscles first make an advance towards those of

* It should hence appear that putrefaction is the only positive criterion of death, or the total cessation of the principle of life. Galvanism has, indeed, been advanced as a positive proof of the same by Behrends and Creve: but Humboldt has sufficiently shown its insecurity as an infallible test.

oxygen, and generally in the softer and more fluid parts of the system; the control of the vital principle being here looser and less severely exerted. An union speedily takes place between the two, and thus combined they fly off in the form of nitric acid; while at the same time another portion of azot combines with some portion of hydrogen, and escapes in the form of ammonia or volatile alkali. A spontaneous decomposition having thus commenced, all the other component parts of the lifeless machine are set at liberty, and fly off either separately, or in different combinations; during which series of actions from the union of hydrogen with carbon, and especially if conjoined at the same time with some portion of elementary phosphorus or sulphur, is thrown forth that offensive aura, which is the peculiar characteristic of the putrefactive process; and which, according to the peculiar mode in which the different elementary substances combine, appears in the guise of the fetor that escapes from privies, from putrid fishes, or from rotten eggs.

In this manner, then, by simple, binary, or ternary attractions and combinations, the whole of the substance constituting the animal system, when destitute of its vital principle, its rational and immortal spirit, flies off progressively to convey new *pabulum* to the world of vegetables; and nothing is left behind but lime or the earth of bones, and soil, or the earth of vegetables: the former furnishing plants with a perpetual stimulus by the eagerness with which it imbibes oxygen, and the latter offering them a food ready prepared for their digestive organs.

In order, however, that putrefaction should take place, it is necessary that certain septics or accessories to such a process should be present, without which, putrefaction will never take place at all. Of these the chief are air, moisture, and heat.

Air must necessarily coexist, for putrefaction can never be induced in a vacuum. Yet we must not only have air, but genuine atmospheric air; or, in other words, the surrounding medium must be compounded of the gasses which constitute the air of the atmosphere, and in their relative proportions. To prove this, it is sufficient to mention that dead animal substance has been exposed by

M. Morveau*, and other chemists, for five or six years in confined vessels, to the action of simple nitrogen, hydrogen, carbon, and various other gasses, without any change that can be entitled to the appellation of putrefaction.

There must, also, be moisture; for, as I have already observed, putrefaction commences in the softer and more fluid parts of the animal system. On this account it rarely takes place during a harmattan or drying wind of any kind, and never in a frost so severe as to destroy all moisture whatsoever; the power of frost exercising quite as effective a control over the elements of animal matter as the living principle itself.

For the same reason there must be heat; since in the total absence of heat, frost must necessarily take place, together with a perfect privation of moisture. On this last account, again, the heat made use of must

* See Mémoire sur la Nature des Fluides élastiques aëriformes, qui se dégagent de quelques Matières animales, &c. par M. Lavoisier, Mem. de l'Acad. 1782; as also, M. Brugnatelli's paper in Crell's Chemical Annals for 1798, Über die Faulung thierischer theile in verschieden Luftarten.

only be to a certain extent *; for, if carried much higher, the rarefaction which takes place in the surrounding atmosphere, will induce an ascent of all the fluids in the animal substance towards its surface; whence they will fly off in the form of vapour, before the putrefying process can have had time to commence, and leave nothing behind but dry indurated fibres, incapable of putrefaction because destitute of all moisture. Our dinner tables too often supply us with instances of this fact, in presenting to us dishes of roast or boiled meat too long exposed to the action of the fire;—and hence, reduced to juiceless and ragged fibres totally devoid of nutriment, and capable of keeping for weeks or months, without betraying any putrefactive indication.

In like manner when bodies are buried beneath the hot and arid sands of Egypt or Arabia, with a vertical sun shining almost without ceasing upon the sandy surface, the heat hereby engendered is so considerable as to raise the whole of the fluids of the animal system to the skin, whence they are

* About 65° of Fahrenheit is the degree usually found most conducive to putrefaction.

immediately and voraciously drunk up by the bibulous sands that surround it; or, piercing their pores, are thrown off into the atmosphere in the form of insensible vapour. In consequence of which, when a body thus buried is dug up a few weeks after its interment, instead of being converted into its original elements, it is found changed into a natural mummy, altogether as hard and as capable of preservation as any artificial mummy, prepared with the costliest septics employed on such occasions.

When dead animal organs are deposited in situations in which only a very small portion of atmospheric air is capable of having access to them, a change indeed takes place, but of a very different description from that of putrefaction, and which is altogether of a most curious and extraordinary nature. For, in such cases, the animal organs, instead of being converted into their original elements, will be transmuted into fat, wax, or spermaceti; or rather into a substance *sui generis*, and partaking a middle nature between that of the two former, whence the French chemists have given it the appellation of *adipocire*; a term not strictly classical, but for which the chemists of our own country have not hitherto substituted any other.

This result is observed, not unfrequently, in bodies that are drowned, and rendered incapable of rising to the surface of the water; for in such a situation but very little air, and consequently very little oxygen, can reach them from the external atmosphere. It was observed also in 1786 and 1787, on opening the *fosses communes*, or common burial caverns in the churchyard of the Innocents at Paris, for the purpose of laying the foundation of a new pile of buildings: for the bodies that on this occasion were dug up, instead of having dissolved into their elementary corpuscles, were found for the most part converted into this very substance of waxy-fat or *adipocire*. The populace were alarmed at the phænomenon, and the chemists were applied to for an explanation. M. Fourcroy, among others, attended upon this occasion; and his solution, which will apply to all cases of a similar kind, referred the whole to the extreme difficulty with which external air obtained any communication with the inhumed bodies, in consequence of the close adaptation of coffin to coffin, and the compactness with which every cavity was filled up. Difficult however as this communication must have been, he conceived that, from the natural elasticity of atmospheric air, some small portion of it must still have entered, conveying perhaps just oxygen enough to excite the new action of decomposition. This having commenced, the constituent oxygen of the dead animal organs would itself be progressively disengaged, and rapaciously laid hold of by all the other constituent principles, from their strong and general affinity to it. During this gradual evolution, there can be little doubt that the greatest part of it would be seized by the predominant azot, a very considerable part by the carbon, and the rest by the hydrogen; and the result would be, upon the total but very slow escape of the constituent and disengaged oxygen, that the whole or nearly the whole of the azot, a considerable portion of the carbon, and a certain quantity of the hydrogen, would have escaped also—leaving behind the remainder of the carbon and the hydrogen, now incapable of escape from the want of oxygen to give wings to their flight, together with the residual earth of the animal machine.

But hydrogen and carbon, though in this case incapable of sublimation from the want of oxygen, would still, from their mutual attraction and juxta-position, enter into a new union and produce a new result, and this result must necessarily be fat; for fat is nothing else than a combination, in given proportions, of carbon and hydrogen. And hence, whatever the respective animal organs of the bodies deposited in these burial caverns may have antecedently consisted of, whether muscle, ligament, tendon, skin, or cellular substance, when thus deprived of their oxygen and azot, the whole must uniformly and of necessity be converted into fat. Pure and genuine fat it would have been, provided there had been nothing left behind but mere carbon and hydrogen; but as we can scarcely conceive that every corpuscle of the azot could be carried off before the total escape of the oxygen, many parts of it must necessarily have assumed a flaky, soapy, or waxy appearance, from the union of the azot left behind with some portion of the hydrogen, and the consequent production of ammonia or volatile alkali; since, by an intermixture of alkali with fat, every one knows that soap or a saponaceous substance is uniformly produced.

But excepting in situations of this kind, in reality, in every situation in which dead animal matter, destitute of its *spiritus intus*, its divine and immortal principle, is exposed to the usual auxiliaries of putrefaction, putrefaction will necessarily ensue, and the balance will be fairly maintained:—the common elements of vital organization will be set at liberty to commence a new career, and the animal world will restore to the vegetable the whole which it has antecedently derived from it.

In this manner is it then, gentlemen, that nature, or rather that the God of nature is for ever unfolding that simple but beautiful round of action, that *circulus æterni motûs*, as Beccher has elegantly expressed it, by which every system is made to contribute to the well-being of every system, every part to the harmony and happiness of the whole: establishing his perfections, confounding infidelity, and overpowering us, whenever we contemplate it as we ought, with the sublimest emotions of gratitude, adoration, and love.

THE END.

Richard Taylor and Co. Shoe-Lane.