ARTICLE V.

A

DISSERTATION

ON

THE PROPERTIES OF

ANIMAL AND VEGETABLE LIFE.

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THERE is no subject, in the extensive circle of physiological investigation, which has excited more attention, or produced more opposite and contradictory opinions and conjectures than Vitality. But neither the wide-exploring researches of philosophy, nor the subtle and acute penetration of metaphysics, has advanced our knowledge of its real nature or essence, in proportion to the number of theories which have been fabricated concerning it. Notwithstanding the much desired light has not been elicited, experiments to determine the properties of living matter, and the

source of those properties which constitute vitality, have not been uselessly multiplied. The observation of facts has extended the sphere of improvement, and the speculations of experimentalists, in many instances, have been rendered practically useful by their subserviency to the elucidation of pathology.

We recur in vain to the medical records of antiquity for a distinct definition of life, or any distinct notion of what it is. The attainments of the ancients, in the knowledge of the true philosophy of the animal economy, were not proportionate to the industry with which they applied themselves to the study of nature. If we review the much famed splendid inquiries, which have immortalized the names of their authors, we shall be more amused by the ingenuity of the hypotheses, and the plausibility of the assumptions, than edified by the number and importance of their discoveries. We every where in their writings witness a vast assemblage of assumed principles, without the deductions which they suggest; a collection of bold and dogmatical assertions, without the necessary proofs; and much mystery conveyed in the imposing jargon of unintelligible terms, without the evidence of those facts, which their discussions promised. Their voluminous productions, like a long and dreary waste, present us nothing to gratify the eagerness of curiosity, nor any thing to compensate the toilsome search of the

diligent inquirer. The reflections of a moment must serve to convince us of the imperfection of their theoretical systems, when we recollect how little was known of the animal economy before the important discovery of the circulation of the blood by Harvey. And equally imperfect and impotent was the knowledge of vegetable physiology previous to the middle of the seventeenth century, when it was scientifically cultivated by Grew and Malpighi, two learned and celebrated naturalists, who, though unknown to each other, published the result of their investigations about the same time.

Researches into the cause and nature of living action were reserved for the more recent cultivators of physiology and medical philosophy. It is the moderns only who have elicited any light which can guide us in our inquiries into the faculties and functions of organic being, or have yielded us any promise of assistance in the attainment of that information, which remains to be acquired. Instead of pursuing their career of investigation impeded by the restraints of systems, the variable and unsettled principles of theories, or by unsubstantial and absurd inferences, drawn from illusive, and ill-conducted experiments, they have with an independence of mind, and an elevation of genius, which, proportioning their exertion to the magnitude of the enterprize, opened the vistas which lead to the consecrated temple of physiological science, and

rendered it accessible to all. They have effected a revolution in opinions, without incurring the disgrace of innovation; have promoted the advancement of knowledge, and the dissemination of its beneficent effects, without seeking the acquisition of glory; and have so minutely investigated, and so perspicuously illustrated, every topic connected with their profession, that all pretensions to originality, and every claim to novelty are denied to their successors. Under circumstances so inauspicious to me, hopeless is the expectation of attempting a course, which has not been rendered familiar to all by the frequency with which it has been pursued;—and it is equally difficult, if not impossible, to avoid the hazard of discussing more imperfectly, a subject, which has often been elucidated by the ablest physiologists.

Though I shall digress on this occasion from the customary practice of discussing some pathological or therapeutic subject, I still hope, though digressing, to fulfil the design of the society in appointing an anniversary discourse. In the execution of this intention, I shall endeavour to present a brief sketch of the phenomena which are exhibited by organized matter, and essentially distinguish it from that which is unorganized. This distinctive characteristic is referible to vitality, by the operation of whose laws are produced those peculiar properties, which we discover in animals and vegetables.

To illustrate these vital properties, I shall institute a parallel description of the general characteristics of animals and vegetables, so far as they have been ascertained by observation and experiments on living matter, and are connected with our present inquiry. A subject so comprehensive, and embracing such a variety of objects, requires perhaps more space than the prescribed limits of a public discourse will admit. But it is presumed, that the structure of each being separately, though summarily considered, their respective functions and properties will be distinctly seen.

Modern physiology has not been content with the mere investigation of extraordinary phenomena, the knowledge of interesting facts, or the delineation of the peculiarity of living action in physical bodies, but has endeavoured, with invincible zeal and persevering industry, to penetrate the obscurity in which they are involved, and to divine their immediate cause. For the accomplishment of this object, mechanical philosophy has been rendered subservient to its purposes; and chemical science has contributed its full proportion of means to facilitate its progress, and to consummate its views. But notwithstanding the accession of these powerful auxiliaries, whose reasonings it has extensively applied to the unfolding of those truly sublime operations of nature, and the elucidation of that series of events, which follow each other

in the order of cause and corresponding effect, its success has not been proportionate to the extensiveness of its enterprize, or the magnitude of its exertions. It is to be regretted that even in these modern systems the tissue of extravagance and idle hypotheses have found a too easy admission, and that their authors, have not at all times recollected, that there is a peculiar unknown something which is denominated life, that maintains a distinctive and important character and influence in the living economy. They appear not even to have remembered that so extensively influential is this principle, that there is not an operation performed in the animal or the vegetable, in all their varied conditions of health, in which it is not incessantly active.

Equally numerous and unsuccessful have been the attempts of physiologists to facilitate the conception of vital causation by the invention and use of terms, or to give a concise and unobjectionable definition of life, which should convey an adequate idea of its real nature or essence. In the Brunonian System, it is asserted in a tone of pardonable enthusiasm, but with all the elation and triumph which ever accompanied an important discovery, "that health, disease, and predisposition constitute the living state, and that life is not a natural but a forced state." The absurdity of the expression has only been surpassed by the absurdity of the doctrines with which this system abounds. An improve-

ment of those philosophic reveries was attempted by the learned but visionary author of Zoonomia, who with more ingenuity than correctness of induction, assumed as a postulation, "that a lactum, subtle fluid, residing in the brain and nerves" effected all the vital changes, and was capable of satisfactorily explaining their origin. But it will be acknowledged that he has amused us with fanciful hypotheses, without distinguishing between cause and effect, and has substituted "mere statements of phenomena for explication of their origin." Equally unfortunate in his definition was the late Dr. Rush in his inquiry into the cause of animal life, where he has endeavoured to maintain the plausible opinion, that "life is the effect of certain stimuli acting on the sensibility and excitability which are extended, in different degrees, over every external and internal part of the body." This may carry the appearance of philosophizing, but will never be admitted as correct experimental logic. But so numerous and familiar are the examples corroborative of our position, as to render a further recital of them unnecessary. They are equally discordant as the contradictory decisions which have been past on the changeable hues of the camelion.

Life is neither a law, nor a substance; it possesses neither visible shape nor parts, and is not an object of any of our senses. We know it only, as we know its author, the primordial

fountain of life, by its effects. We are able to examine its properties, and to study its operations, but not to penetrate the veil which shrouds in inscrutable darkness, its cause. The intelligence of man is too feeble and limited to discover or define this great and anxiously sought for phenomenon of organization. It is equally evolved in the humble moss that vegetates at the foot of the oak, as in man, who, from the peculiarity of his structure, is destined to occupy a wider and a more extensive sphere of activity. The myriads of animals which inhabit our globe, and the mysterious and inexhaustible variety of vegetables, which diversify and embellish its surface, are organized beings, endowed with properties unknown and undiscovered in minerals or fossils, and which cannot result from any chemical affinities. They are characterized by a vital agency which is superior to the principles and laws of common inert matter. They exhibit, on an accurate inspection, one constant and uniform scene of motion and activity, of growth and decay, of waste and renovation, and of death and reproduction. Considered in their number, their variety, their elementary principles, their different functions, and their structure, they are incontestable evidences of unerring wisdom and contrivance, and yield us the most indubitable proofs, that nature has not abandoned even the most insignificant of her works to chance, to misrule, or to blind and random im-

pulses. They are so many organized bodies, and consequently so many living beings. All the phenomena of minerals are resolvable into the attractions and repulsions of cohesion, crystallization, gravitation, magnetism, electricity, heat and light. As they possess no organized structure, they can neither originate by generation, nor grow by nutrition. They derive their increase in bulk from crystallization, chemical attraction, or the juxta-position of extraneous substances, or from a dilatation of their particles occasioned by the expansive and repulsive power of caloric. But they neither see, nor hear, nor feel, nor smell, nor taste, nor are they moved, except by the impulse of impinging bodies. They are "masses of mere dead unorganized matter, subject to the laws of chemistry alone." We look in vain even among their curious crystallizations to discover a principle, which, by the most distant analogy, has any resemblance to the vital principle of organized bodies.

In every systematical investigation of the science of living matter, this common mysterious principle has been designated by different appellations, as if the potent spell of a name, significant of an effect only, should possess also the talismanic power of developing the cause. It was called Nature by Hippocrates, the Vis medicatrix naturæ by Stahl. It was the favourite Archæus of Van Helmont; the Excitability of

Brown; and the vis vitæ, the anima, the vital principle, and similar expressions of the recent cultivators of physiological science, invented by them to convey an idea of the unknown cause of the known operations in an organized body. But it is apparent from the very conception of the terms employed, that they are inadequate to explain the source from whence all the phenomena of life originate.

In all our attempts to philosophize, we have recourse to abstract terms to convey our secondary perceptions, and without this aid, we should be unable, either in reasoning or thinking, to make inferences, or to draw conclusions.—But these terms are not more objectionable on account of their total inapplicability to the communication of the intended knowledge, than with respect to their import. Each of these expressions implies a *unity* of the vital principle, one simple unmodified power, common to all living beings, and capable of explaining all the phenomena of vitality. The absurdity of such an hypothesis would be sufficiently proved by a very cursory examination of the animal or vegetable economy. There is not only an essential difference in the structure and texture of the different organs, but in the functions they perform. Will it be admitted that the functions of the brain, the heart, the lungs, and the stomach are referable to the same principle? It exceeds belief that a single principle is capable

of accounting for all the varied operations, the different functions and properties discoverable in these organs, since some of them are possessed equally by inanimate substances as by living bodies, and therefore not referable exclusively to a living principle. Or that the agency which animates, sustains and renews these organs, and the laws which regulate and govern the circulation in the heart, the respiration in the lungs, or digestion in the stomach, can emanate from one and the same principle. It scarcely requires to be observed, that such an opinion is predicated on a basis that is not tenable; and that no satisfactory evidence has ever been adduced in support of it. It has been founded on an unproved assumption, is opposed by facts, by observation and experiments, and will be rejected by common consent.

As great a contrariety of opinions prevails respecting the *seat* of this occult vital principle, as has existed among physiologists concerning its supposed unity. But when error is not a practical evil, the pertinacity of contumacious ignorance is harmless. Mr. Hunter maintained that it resided in the blood; M. Le Gallois in the medulla spinalis; while other physiologists of equal celebrity have respectively assigned it the heart, the lungs, the brain and nerves, as its appropriate residence and sole repository. But it has been incontrovertibly demonstrated by experiments, the accuracy of which has never been

questioned, that neither of these organs is exclusively the seat of the vital principle. It is a well attested fact that fetuses have been born alive, who possessed neither brain nor spinal marrow, and in whom no traces could be found that these organs had ever existed. It is also acknowledged that life is not immediately arrested in consequence of an ossification of the heart, an ulceration of the lungs, or a partial destruction of the brain, and that these organic lesions will occur, without producing a sudden suspension of their functions. The powers of respiration continue after decapitation, and the heart continues to act for an indefinite length of time, after it is removed from the body. But it is not the design of the present inquiry to attempt a reconciliation of the apparent contradictions and discordant doctrines and inconsistences, nor a refutation of the hypotheses which have been fabricated concerning them. Having no particular theory of our own to advance, nor any favourite tenets to establish, we do not feel ourselves privileged to indulge in conjecture, and must enter our solemn caveat against the entangling mazes of metaphysical subtleties, and the delusive but fascinating charms of physiological fictions.

As we can neither develop the cause of life, nor arrive at any correct definition of it by chemical analysis, nor gain any thing by reasoning on the nature of its principle; we turn to the consideration of the effects and phenomena of

vitality, which constitute the proper objects of physiological investigation.

Animals and vegetables alike experience all the vicissitudes of infancy, maturity, decay and death. The duration of their existence exhibits nearly the same phenomena, and the shades of resemblance might be traced through all the gradations from their first feeble and tender condition, their slow and gradual advancement in size and strength, their full and vigorous maturity, to their ultimate decline, and the euthanasy of old age. When submitted to anatomical inspection the analogy is equally plain and perspicuous. We see in each an assemblage of solid and fluid parts, intimately and intricately connected, mutually dependent on each other, exercising various functions, and organized into one perfect whole. Of these parts, the solid, inextensible, woody fibre, and the external cortical fibre of the vegetable is strictly analogous to the bones, shell, horn and nails of animals. Each of these possesses an insulation of vitality; has its periods of growth, and decay, and is alike subject to injuries, diseases, and death. And we might, without trespassing on the confines of fiction, pursue the analogy between the vascular system of the plant, and the lymphatic, and blood-vessels of animals, each of which is endowed with contractility and a susceptibility to the impulse of stimuli. On an examination of their respective systems, we every where see,

in their solid parts, vessels, distributed for the conveyance of fluids, which in the course of their circulation impart nourishment, and supply the waste occasioned by the excretion of old matter. All their vital organs are incessantly active during health, from infancy to decrepitude, and are never wearied, nor require repose. But by studying their anatomy we derive no knowledge of their functions. All we know of this, is acquired by patient and laborious observation, by frequent inspection of recently dead bodies, or by experiments made on living bodies. And all the information at present obtained respecting animals and vegetables, as living bodies, is restricted to a few particulars, which may be comprehended under a consideration of their composition, their structure, their functions, their appetites, and their vital properties. Each of which claims a separate and distinct discussion, in order to preserve the general view entire and unbroken.

From a cursory inspection of the animal and vegetable economy, it would be obviously inferred, that parts so different in conformation, and so distinct in their functions and vital properties, would necessarily be equally different in their composition. But we are not to confound their exterior form and attributes, and their immediate materials and integrant parts, with their elementary substances, which constitute the basis of their organization. We

cannot, however, in the present state of philosophical knowledge, and chemical analysis, affirm with unerring certainty respecting the various combinations of the elements which exist in animal and vegetable bodies during life, and co-operate with the vital principle; since all we know of these ultimate elements is derived from decomposition on the cessation of life. But so long as either an animal or a plant is capable of being influenced by the vital stimulus, the constituents of their immediate materials, are not susceptible of forming any other combinations, nor are they subject to the laws of chemical decomposition. It will be recollected, and with regret, that such is the peculiar nature of all living matter, that it is impossible, in its living state, to subject it to such decisive experiments or chemical analysis, as have so amply contributed to improve, illustrate and exalt the science of natural philosophy. But so far as chemists and physiologists have hitherto extended their researches and observations, they have found these ultimate elements a common boon, participated alike by vegetable and animal bodies. It is these elements which we particularly regard in their composition.

The same remarks which will apply to the *structure* of a living animal body are equally applicable to a living plant. In both we observe an assemblage of individual parts differing in their fibre, composition and tissue, possessing

their respective and appropriate organs, but differently modified and harmoniously combined into one whole. Nature has variously interwoven and united these parts, and established among them a difference of texture and configuration by which they are perfectly identified. But in the form of the organs, nature claims no superiority over the wonderful subtility of mechanism, which possesses the power of imitating them in shape, size and colour, with a correctness of resemblance capable of imposing on the senses of the inexperienced. But art, though plastic, cannot reach their elementary parts, nor successfully imitate their inexplicable texture.—These are produced, assimilated and elaborated by the vital functions. In considering therefore the structure of living bodies, we are principally to regard the texture of their different parts, the combination of parts of dissimilar texture, and that configuration of the various organs which results from such combination.

In discussing the *functions*, I shall not adhere to their arbitrary divisions and subdivisions into classes, and orders; but shall pursue a course more summary, and attended with less prolixity. And in rejecting every classification with which we are acquainted on account of their palpable inaccuracies and inconsistencies; we feel compelled, at the same time, to withhold our approbation of the visionary chemico-animal philosophy of some modern physiologists, not more for its encouragement of materialism,

and its demoralizing influence, than for its total incapability of explaining those vital actions, which we believe are solely the production of a distinct principle, whose agency results from the animating power on an organized body. In describing therefore the functions, it is necessary to demonstrate that the organs possess certain powers peculiar to living bodies. For if they maintain a certain configuration, and are composed of parts of a certain texture only, without some other characteristic, they cannot be discriminated from dead matter.

In tracing the analogous functions of animals and vegetables, let us examine those which serve for the preservation of the individual, under the triple relations of those of assimilation, those of formation, and those of excretion. By the performance of these complicated functions we can satisfactorily account for the growth, the waste and consequent reparation of the system, and the subserviency of vital support to vital action, without having recourse to chemical affinity or aggregative attraction. And in passing, it will not be irrelevant to observe that all the organs which have been called vital, are hollow muscles, but destitute of opponent muscles, and that they are elongated by their contents, which contents, except in the alimentary canal, are in a fluid state, and excite these organs to contraction.

By the functions of *assimilation* foreign matter, which consists principally of dead animal and vegetable substances, is constantly and uniformly converted into the peculiar nature and substance of the animal or vegetable which has taken it for its nourishment, support and renewal. The apparatus subservient to this purpose in animals, consists of various organs, as the mouth, the stomach, the intestines and chyle vessels, in which the aliment is received, decomposed, differently modified and conveyed into the mass of fluids, to maintain the perpetual change in the materials, which enter its composition. It will be generally conceded that no chemical or mechanical forces are adequate to the accomplishment of similar results; and that the process of assimilation is therefore an effect of the operation of the living principle. To remove even the possibility of a doubt, let the experimentalist, aided by chemical and mechanical agents, produce from any combination of matter, chyle or blood. But in Nature's laboratory, however heterogeneal may be the quality of the food, the same kind of blood and chyle is constantly and invariably produced from it. No difference of climate, no national peculiarity, nor any regimen, from the simple food of the first progenitors of the human race, to the profuse variety of the modern delicacies of an epicurean banquet, have effected a deviation in the result of this process. The same

red blood, in quality, flows in the vascular system of the Italian, who revels in the luxuries of his macaroni, as in the veins of the Kamtscatkan, who gormandizes the rancid fat of the whale ;—the same in the vessels of the Caffre, whose principal food is milk, as in those of the Mongal or Calmuck, who with equal avidity devours the flesh of their horses ;—the same red blood circulates in the arteries of the Turk who subsists on rice, as is found in the arteries of the Moor who confines his repasts to figs ;—and the same is observed in the vessels of the Hindoo, who never mixes animal food with his rice and ghee, as in those of the natives of our western wilds, who feast on jerked venison, rendered grateful to their palates by being enveloped in bear's oil.

Having seen what passes in the animal body, let us examine the vegetable system, and observe how this process is conducted there.—Though experiments, equally numerous and decisive, have not been instituted, by which the organic functions of plants would be incontrovertibly ascertained, nor has vegetable physiology, been investigated with that zeal which characterized the labours of the ardent and penetrating Bichat, yet, as limited and as imperfect as is our knowledge, enough is known for the purposes of our discussion. Plants are furnished with an apparatus of minute and delicate vessels, which are perfectly analogous in

their functions to the stomach, lacteals and arteries of animals. The aliment which the roots receive from the soil is deprived of its nutritious particles by the sap vessels, and these nutritious portions are conveyed by absorption into the fluids, and by the circulation of the sap they reach the flowers, the fruit and the leaves of the most remote branches. It has been experimentally, and unquestionably demonstrated, that there is not a particle which enters into the composition of a plant, that is stationary for a moment, and that this change is incessant not only in the trunk, but in the extreme part of their leaves. From this view of the vegetable economy, we shall not incur the imputation of a petitio principii, if we affirm that there is not any one conceivable part of time, in which it could be possible for chemical or mechanical powers to exert their influence. We must therefore infer that vegetables like animals assimilate the food they receive, perform their destined functions, and by means of the nourishment they receive, attain a magnitude unparalleled among other organized bodies. It is in the diversified operations of their respective economy, in this intricate round of the functions, that consist the truly sublime considerations of philosophy.—Whatever may be the particular nature of the food absorbed, or other local circumstances, we witness in the same species of vegetables, the same unchanging effects are produced from it.

In our own forests we see the oak, the maple, and the pine, taking root and growing in the immediate vicinity of each other, drawing their nourishment from the same soil, surrounded by the same temperature of the atmosphere, imbibing the same dews, refreshed by the same showers, and invariably the same in all the external circumstances, which are necessary for their growth, their support, and to supply their continual waste. Whatever may be the properties of the aliment which the root-vessels of these tress respectively receive, the maple will constantly and uniformly produce a saccharine juice, and the pine a resinous fluid. The agency of the vital principle only is adequate to account for these wonderful operations, though we are unable to comprehend the instruments by which they are effected, or the laws by which they are regulated.

In the preceding observations on the animal economy, it was intended to give a sketch only, a mere miniature representation of animalization, without describing the various changes of the food in its circuitous course through the chylopoietic viscera, its decomposition in those organs which subserve assimilation, or the additions it receives, or the parts it rejects. The fact is sufficiently obvious, that each organ takes from the circulating current the aliment which is best adapted to the fulfilment of the designs of nature, and will most effectually contribute to

the nourishment, the increase and renewal of the body. But whatever may be the quality of the food received by animals for assimilation, it is decomposed by the digestive and secretory organs into earth, alkalies, acids, neutral salts, albumen, fibrine, mucilage, &c. And in vegetables, by a similar process, it is converted into earth, alkali, acid, mucilage, &c. forming a catalogue of vegetable matters of too formidable length to enumerate on this occasion. The secretion of a substance which has not the most distant resemblance to the food received, is the exclusive property of a living being.

In sketching the leading facts connected with the functions of assimilation, we necessarily glanced at the functions of formation, by which we have partially anticipated many of our remarks on their distinctive characteristics. The extreme vessels are the organs principally exerted in the performance of the functions of formation, and are the media through which is originally and successively communicated the new matter, of which are formed the various solid and fluid parts of our bodies. It is these curious and interesting operations of the animal economy, which so much excite our admiration. The capillaries are the reservoirs of that heterogeneous fluid, the blood, from which the exhalant and secretory vessels, and those which perform nutrition, derive their supply. And we every

where see this unbroken continuity of supply equal to the perpetuity of waste. During this incessant change, the body maintains nearly the same external configuration, and the same form and texture of its internal organization. We shall in vain resort to chemical agency for an explication of the process of nutritive elimination from alimentary substances; and we shall find it equally difficult to account for the subsequent union of the secreted fluid with the solid and the fluid parts of our bodies by the effects of a mechanical juxta-position of particles. Similar general and individual laws which govern and direct the animal economy, preside also over the vegetable system. They are immutably established both in the external and internal structure of every animal and plant, and either accompany or arise from organization. In the same species, whether of animals or of vegetables, we observe nearly the same shape, size, disposition of parts, and complexion or colour, perpetuated through succeeding generations. The distinctive character of the Ethiopian is not more permanently fixed in his features, figure, complexion and stature, than that of a plant in its trunk, branches, foliage and fruit. The peculiar black skin, the curled hair and depressed features which the African exhibits at this day, were exhibited in the ancestors of his race a thousand years ago; and the aloe, in an equal space of time, has preserved invariably the same singular configura-

tion of its leaves, and the same variety of spots, and various hues of its blossom. Hence we infer, that we derive no knowledge from the chemical analysis of soils, by which we can detect the common principle subservient to the nutrition of vegetables; and that the separation and assimilation of nutritive matter is predicable only of a vital action.

If the preceding view of the subject is, on investigation, found to be correct, it may be applied to the explanation of the nature, and the improvement of the treatment of certain diseases. Dr. Cullen and his humble devotees, imagined that a saccharine matter was the prime principle of nutrition; but would one of the disciples of this school undertake the cure of a diabetic patient, in the extreme stage of emaciation, by the exhibition of sugar? Or, what scientific physician would administer the phosphate of lime to an infant afflicted with the rickets, because it was evident that the disease arose from a loss to the bones of a due proportion of this substance? These and similar disorders are only remediable by an excitement of those vessels in which are performed the functions of formation.

We have seen, in considering the functions of assimilation and formation, the constant change which the whole animal and vegetable body suffers by the perpetual deposition of new matter, and the incessant renovation of parts. We are

next briefly to notice the function of excretion, by which, in the natural routine of the system, the old solid and fluid parts of their bodies, and even the vessels themselves which perform this office, are decomposed, and conveyed away by the emunctories. The enumeration of the various excrementitious fluids which are ejected by the excretory vessels in animals, is unnecessary in this place. We announce the fact as incontrovertibly established, and believe that it can be demonstrated, that vegetables are endowed with analogous functions. The belief of the existence of these functions in plants is not founded on inferences drawn from mere suppositions and loose conjectures, but from experiments and observations, which have been made with an accuracy and fidelity that does not admit of deception.

Those functions which we have rapidly sketched, and to which we have confined our observations, are exercised in common, and possessed by the individuals of each sex; and in further prosecuting our inquiry, we shall with equal brevity attempt the consideration of those which have been denominated the sexual functions, which were provided by nature for the preservation, not of the individual, but of the species.

An identity in the phenomena of the generative process in animals and vegetables supposes an identity in their sexual organization. But the organs and vessels which are concerned in

perpetuating a succcession of organized beings of similar species are so familiarly known as not to require an enumeration, or any particular description on this occasion. And it may be further remarked, that most theories respecting conception are mere philosophical speculations, unsupported by a series of connected and well authenticated facts, and so far exceed probability, as to surpass belief, and to put honest credulity to the blush.

It is manifest to common observation, that there is an incontrovertible similarity in the process of the reproduction of the same species of animals, and the same species of vegetables, by sexual intercourse. The manner in which the vivifying principle, which animates the germ produced by the female, is communicated, is more than merely analogous. In vegetables the anthers of the stamens eject the pollen on the stigma, similar to those animals in whom reproduction is performed by the approximation of organs. In this admirable economy of nature, though her recesses have never been satisfactorily explored, we witness the synchronous operations of the sexual functions, by which the species have been perpetuated.

It is very evident that there prevails not only a diversity in their reproductive organs, but a difference in the mode of propagation. The Abbe Spallanzani has demonstrated by his observations and experiments on frogs, toads and

newts, that the introsusception of organs in these animals is not necessary to their reproduction. And in like manner the functions of the stamens and pistils, in many vegetables, are accomplished without contact, the pollen being brought to the stigma by the air, by the foot, and by the wings of insects. But by whatever means this commixture of the pollen with the fluid which moistens and covers the stigma is accomplished, the fecundating stimulus is communicated, by which fruit is perfected, and the designs of nature fulfiled.

THERE also occur both in the animal and vegetable kingdoms, anomalies resulting from the sexual intercourse of different species; where the sire is of one kind and the dam of another. In the animal productions of this description are mules, the offspring of the horse and the ass, and mongrels, the progeny of the wild and the tame goose. Among vegetables the hybridous plants are occasioned by the pollen of one species falling on the pistilla of another; many curious and singular instances of which have been recorded by Linnæus, the accuracy of whose luminous experiments has never been questioned, nor has his veracity been impeached. Were it necessary, various examples of similar deviations from the usual course of nature, might be adduced in corroboration of the principle intended here to be established.

Modern physiologists have likewise attempted to prove the vitality of vegetables by the phenomena of their diseases. This subject is both curious and interesting to the naturalist, and, if scientifically investigated, unincumbered by previous theoretical impressions, might be rendered of practical utility to the agriculturalist. A full development of our views on this topic would require a minuteness of detail, and length of discussion, that would be inconsistent with the limits of our present inquiry. There is nothing fanciful, however, or enthusiastically unreasonable in the suggestion, but on the contrary, innumerable instances are to be found in every physiological treatise on botany. In the diseases of animals and vegetables there is not merely an imaginary resemblance, founded on the uncertainty of presumption, but the analogy is established by the clearest and most demonstrative evidence. The same want of vital energy in a part, or the same weakened action of the vital functions, which terminates in sphacelation, gangrene, or mortification in animals, produces the same diseases, with all their attendant circumstances, in vegetables. The effects of mechanical lesion, of frost, of poverty to the one, and unskilful husbandry to the other, are attended with the same deleterious consequences in each. When either is exposed to the rigorousness of excessive cold, the functions in the extreme parts are disorganized, the secretions ob-

structed, the fluids in their vessels interrupted, and the part becomes decomposed and subject to the laws of dead matter. When the same effect no longer results from the same agents, disease is the necessary consequence. Like animals, vegetables frequently languish, sicken and die, from the ravages of parasitic animals and vegetables. This is particularly exemplified in the mildew, the blight in corn, the ergot in rye, the moss which fixes on old trees, the morbid protuberances on oaks, and the depredations of the aphis, the puceron and the caterpillar. Had there been the same strong inducements to study the peculiarity of the constitution, and to investigate the distinct nature of living action in vegetables, as there has been evinced in the elucidation of the animal economy, we should have attained a more perfect knowledge of their diseases.

It is familiar even to those who have never systematically engaged in physiological researches, that a certain degree of heat is requisite to maintain animal existence, and to support the vegetative principle. Many individuals, of both of these kingdoms of Nature, also possess the power of maintaining a certain temperature amid the perpetual snow of the polar regions, or the intense warmth of the torrid zone. These are well known facts, and, if the evolution of the caloric, which supports animal temperature, is allowed to be a secretion, it must necessarily

be regarded as a function of the nervous influence. From the admission of this fact, we deduce the evidence of the existence of a nervous system in vegetables, since it will be granted that they also are capable of occasioning an evolution of caloric.

These remarks on their analogous composition, structure, and functions, were necessary preliminaries to a consideration of their vital properties, which result from their respective organization, and are exercised in the performance of the functions.

These vital properties vary in number, degree and intensity, according as the organization is more or less complicated and elaborate.—Hence they have been differently denominated by different physiologists, and the exposition of their cause and origin has produced various and contradictory hypotheses. Among the competitors for the honour of discovering their true source, a few, allured by the meteor glare of novelty, have reposed a pretended confidence in the potency of galvanism; others of equal pretensions, and equally enthusiastic, have accounted for their phenomena by the influence of electricity; and those, who have renounced the philosophic reveries and illusive dreams of the ancients, have found an easy solution of their cause in mechanical and chemical agents.—Hence systems have been built on the hypotheti-

cal doctrines of vibrations, oscillations, electrical attractions, and chemical actions.

It will be deemed superfluous, on this occasion, minutely to detail the evidence of the existence of the vital properties belonging to living bodies, or circumstantially to point out the process by which they may be discovered.—We show what they are, and define them. And in our selection we shall enumerate only those, whose existence has been the most unequivocally ascertained, and which have been recognized by the most approved physiologists. In describing them it will be evident that they are distinct properties, and that the aggregate of these properties is to be regarded as constituting animal or vegetable life. We shall consider them as consisting of mobility, irritability, vital affinity, vivification, sympathy, and sensibility.

We begin with *mobility*, which is an original power of motion in living beings, and is manifested in those organs which perform the functions of assimilation, formation and excretion. It is a property which cannot with strict propriety be said to reside exclusively in the muscular fibres, for parts in which no such fibres have been demonstrated are capable of original motion. All the moving parts of the body are capable of moving themselves independently of any external motion impressed. Since it has been conceded by every physiological writer

that it is a property belonging both to living animals and vegetables, it is unnecessary to multiply illustrations.

Another character of all organized bodies is *irritability*. This is a property in animals by which external applications to particular parts excite a motion in the moveable parts, independently of the motion impressed. We regard the muscles as its essential seat, and in its modification we recognize a diversity as various as the peculiar and specific mechanism of the muscles. Though it presides over those organs which possess mobility, it is discriminated from it by being found to reside in parts, in which this vital energy is not exercised. We also observe it in the blood vessels and the lymphatics, and can trace it in parts remotely situated from those to which the stimuli are applied. We would adduce in confirmation of this position the familiar instance of the application of irritation to the different mucous surfaces, as is evinced in sneezing in consequence of irritating the pituitary membrane, or coughing from an irritation of the bronchiæ; not to mention the spasmodic vomiting which is produced by biliary calculi. Having observed that contraction succeeds irritation in all cases, excepting those of the iris, the corpus cavernosum, and the sphincters ani, vaginæ, and vesicæ, it has been inferred by professor Blumenbach, and most of the zealous

opposers of the celebrated Hallerian theory of irritability, that *contractility* is a distinct vital property. But it is equally obvious in the examples recited, that contraction follows dilatation, on the removal of the irritation, as the muscles in other cases of irritation resume their former situation and dimensions on the discontinuance of the contraction.

Consistently with my design in this analogy, it is necessary to demonstrate that irritability is also a property of vegetable life.

Innumerable experiments have been instituted with a view to determine the existence of this property in vegetables, and from the result of these experiments there can no longer remain a doubt on the subject. To what, I would ask, shall we attribute the motion of the sap, but to irritability? It has been ascribed to the peculiar form of the vessels, and to the agitation of the wind, but these cannot be admitted as adequate causes. Neither will we allow that it is occasioned by the action of heat, nor believe with Tournefort, that it is propelled through the vessels by capillary attraction. It is manifest that it cannot be owing to the influence of heat, since it is well known that the sap vessels originate in the alburnum and near the pith, and that the sap flows in the forest in the spring before the greatest warmth of the solar rays is felt.—And it is repugnant to reason and sound philoso-

phy to believe it possible for capillary attraction to be exerted to the known altitude to which the sap ascends.

The fall of the decaying foliage in autumn, of every deciduous tree, or shrub, is to be accounted for on this principle only, the state of its irritability, and not by any chemical or mechanical agency. The foot-stalk of the leaves and leaflets of the sensitive, and many other plants, when irritated, exhibits undeniable proofs of this vital property. Thus it is evident that the application of irritants cause the fibres to contract, and the contraction gives motion to the leaf. We therefore consider it as a fact demonstrated, that if contractility is a property of animal life, it belongs also to vegetable life.

We shall next consider *vital affinity* as one of the energies of animal and vegetable life. I cannot better illustrate the subject, than by adopting the sentiments and quoting the observations of the inventor of this term,* who has remarked that the facts, from which the existence of this property is inferred, have not escaped the notice of modern physiologists, notwithstanding they have not characterized it in their classification of the vital powers. The name, though borrowed from the analogy presented us by one of the sciences, will be acknowledged

* I am indebted to James Jackson, M.D. Professor of the theory and practice of physic in Harvard University, for the terms vital affinity and vivification. New-England Journal Vol. V.

appropriate, and that it sufficiently designates a source of action, and the effect, which constantly occur in certain physical phenomena, without confounding it with those mutual attractions or affinities which are purely chemical.

This vital property is recognized in every living organized being, and must exist in every part of matter endowed with vitality. If this fact is not sufficiently ascertained, it is rendered more than probable that the first communication of it to foreign matter is in the digestive process, and that the subsequent assimilation of the nutrimental fluids forms new combinations. This we witness both in the animal and vegetable economy, where we see the fluids separating and combining in new affinities, and the action of the solids controlling the affinities and new combinations of the circulating fluids. This is not simply chemical, for if the elements of living bodies were combined by chemical affinity, they would not undergo decomposition. We know that the ultimate elementary particles, the basis of organization, are the same in all substances, but their combination in living bodies, by attraction or affinity, is different from the combination of these particles in inanimate matter.

The facts, from whence the evidences of the existence of this property in animals are adduced, have been ascertained with a precision and certainty that cannot leave a doubt on the mind of any physiologist; and from the foregoing ob-

servations on the functions of secretion, nutrition and assimilation, it must, I think, satisfactorily appear, that vital affinity is a property of vegetable life.

Another property of life, which presents itself to our notice is *vivification*. In the countless multitude of organized beings, by whom we are surrounded, we recognize a constant, never-ceasing change of the particles of which they are composed, and by which they evince incessant material death and reanimation. All organized matter must be perfectly decomposed or dead before it can live; must be decomposed or dead in the stomach of animals, or in the soil which nourishes the plant. This conversion of inanimate to animate matter yields us the most satisfactory proof that we have only a faint and evanescent glimpse of the intricate and admirable operations of nature, and of that steady and ceaseless energy by which the same effects tend to the accomplishment of the same ends. It must be regarded as one of the mysterious, if not inexplicable phenomena, that life is maintained and communicated, amid perpetual dissolution. This property in living organized bodies of making other matter live, is vivification, and it exists in the extreme vessels which perform the functions of formation.

We have seen these organs of the vegetable destined to exercise the formative functions, exerting an influence on the fluids, by which, not

only the perpetual waste of the parts is incessantly supplied, and the parts themselves renewed and supported, but animation or life successively communicated to these renovated parts. While these organs are bestowing on the different parts their peculiar structure and composition, they bestow on them at the same time, their appropriate vital properties. From this concise view of their functions, it is as obvious that vivification is a property of vegetable life, as it is to infer from their increase, that food is received into their system.

According to the order of arrangement, which I have adopted, *sensibility* is the last vital property proposed for consideration. In the illustration of this subject, perhaps it will be imagined, that I have attempted to give to the vegetable system a character, which no correct physiologist will allow that it possesses; a character which all, who feel a pride in the dignity of human intelligence and the importance of the intellectual functions, believe that nature has intentionally withheld from it. But whatever rank is assigned to vegetables in the scale of creation, we know that they possess all the other properties of life, manifested by animals in the exercise of their functions; and if we cannot satisfactorily prove that they are endowed with sensibility also, I shall be content with rendering it merely probable. I feel justified in the attempt, since the contrary opinion, which is

universally embraced and propagated, has never been incontrovertibly demonstrated.

By the recent investigations of the operations of physical bodies, we are more completely initiated into their arcana; and conducted by their various analogies and discrepancies, we pass the threshold of enlightened philosophy, to the inextinguishable light of truth. Those phenomena, which cannot be accounted for by electricity, or galvanism, or by any chemical or mechanical principle, are not for this reason to be considered as inexplicable, and consigned over to be ingulfed in the interminable vortex of mysticism. We would rather allow to the humble vegetables, which carpet the earth on which we tread, perfume the air we breathe, and delight the eye with the richness and variety of their hues, the possession of a vital energy, which is not denied to the worm that entwines itself in their roots, or the insect which revels in their blossoms, or preys upon their leaves. But let it be remembered, that however degrading in human estimation may be the situation, which vegetables are destined to occupy, the air which they evolve is inhaled by man, and that the materials which circulate in their frame, in the circle of eternal change and regeneration of matter, may shortly hold communion with an immaterial spirit.

We live in an age of progressive improvements in all the sciences; and within the short

and evanescent period of our own recollection, facts have been multiplied respecting the laws of the vital functions, which admit of no parallel in the annals of physiological records. The moderns, as if unwilling that any thing should escape their scrutinizing researches, have had the presumptive hardihood to subject to the most cruel and torturing experiments, the bones, the tendons, the ligaments, cartilages, &c. of animals, possessing intelligence, the faculties of speech, and the capacity, in the most significant and unquestionable manner, of communicating their sensations, to determine if they possessed either vitality or sensibility. By cutting, pinching, tearing, burning and irritating, by chemical and mechanical agents, they have at length demonstrated that these parts, before deemed insensible, are endowed with both life and sensation. And may it not from hence be inferred, that as the structure and intimate nature of the organs of plants, are so nice and delicate as heretofore to elude anatomical investigation, that they may nevertheless possess sensibility in proportion to the minuteness of their structure? If not in the perfection observed in the more perfect animals, equal at least in degree, with many in whom there has not been discovered either a brain or a nervous system? We have been furnished with no data, nor standard, nor criterion, by which the admeasurement of the degrees of sensibility is to be precisely ascer-

tained, or the capacity, which the individuals of different species possess of enduring pain, or of enjoying happiness. It has not been proved that the sensibility of zoophytes, in whom there exists no evidence of a nervous system, is not in degree equal to that of an elephant or rhinoceros, whose nerves are proportionate to the size and magnitude of their bodies. Nor does it appear that the sensibility of living fetuses born without a brain, and worms, insects, crustacea, and mollusca, in all of whom a brain is wanting, is not commensurate to that of the human species. We believe that vegetables have as strong a claim to be characterized by this property as clams, or oysters, or polypi or the myriads of animalculæ infusoriæ. We regard not the circumstances which originate in their necessities, whether they walk on two or four legs, whether they creep on the surface of the earth, or wing their way through the trackless regions of the air; whether they pursue their silent course through the bosom of the ocean, or respire through lungs or gills. If they live they feel.

We assert it as a fact, incontrovertibly established, that there is no definition of irritability as yet invented, not even admitting the influence of this property in its most unlimited and unrestricted application, which is adequate to the explanation of many of the phenomena exhibited by the mimosa sensitiva, and numerous other singularly curious plants. I have not, however,

the temerity to affirm that these are positive, conclusive and plenary evidences of sensorial power; but I am bold to assert, that there is no chemical or mechanical principle, or any known vital energy applicable to their explanation, but sensibility. We do not appeal, for a decision, to opinions, the vague and indeterminate criterion of truth, better calculated to mislead, than to convince the doubting; but to undeniable, authenticated facts, to be found in almost every treatise on vegetable physiology. We have no hesitation in maintaining, that if we attempt a solution of their mode of action, other than that resulting from sensibility, we shall be involved in a perplexity of causes, as interminable as a circle, and which leave the solution as inexplicable as the fact itself. From the definition of irritability it necessarily follows, that the application of an irritant to the same part of a vegetable must be invariably accompanied by a manifestation of the same event. Let us see how apposite this distinguishing characteristic of irritability is to the well attested instance related by Gerardin of the mimosa sensitiva, which was conveyed by the celebrated Desfontaines in a carriage to a considerable distance. The first effect of the violent motion of the coach was to induce a contraction of the leaves of the plant, but after a lapse of a few moments, notwithstanding the motion of the carriage was continued with equal violence, no collapse of the leaves occurred.

Hence it may be reasonably inferred that the power of the application, producing sensation, in this instance, was diminished or destroyed by custom; as is evinced in the inhabitants residing in the vicinity of stupendous cataracts, who become insensible, from custom and habit, to the impressions, which the incessant roar of these waters are calculated to produce.

An additional argument in confirmation of our hypothesis, possessing in our estimation that weight of evidence, which renders it more than probable, is, that vegetables exercise vital functions analogous to those animals, which possess the organs on which sensation depends. In the most perfect animals supplied with a brain, spinal marrow, and a common sensory, nutrition and secretion are evidently influenced by the nervous power; and observing that the functions are performed in plants and the less perfect animals, in whom neither brain, nor nervous system has been detected by the most accurate inspection, we cannot hesitate to allow it as a necessary inference, that a power resembling the nervous influence, or the more circumscribed operation of a nervous system, must also exist in them. Whatever therefore, either in animals or vegetables, acts as a substitute for a nervous system, by exercising its functions, whether it be instinct, electricity or galvanism, must be capable, in the most unequivocal manner, of communicating the impression of a stimulus,

from the irritated contractile fibre, to the common sensory, where it is perceived or felt.

To avoid the imputation of practising a disengenuous evasion of the question, and to prevent any ambiguity which may arise from the use of terms, we shall admit, as an approved definition, by the best physiologists, of sensibility, that it is that property in the organs, by which we are apprized of the impression made on these organs by external substances. To this it will not be objected, that the motion of the blood in the heart and arteries is not felt, or that certain organic, visceral and fibrous contractions, excited by the appliction of stimuli, are not communicated to the common sensory. It is notorious that in these instances, we are not apprized of any motion produced, nor of the sensation superinduced. But we hasten to make the application of the definition to the vegetable system, by inquiring, how the dionæa muscipula is apprized when to close its singularly constructed leaves, and to seize upon the insect that has entered its bosom, and not again to relax its grasp till its prey expires? The impression here made elicits a motion, but not by the application of a stimulus to the contractile fibre, to the footstalks of the leaves, and is not therefore to be regarded as a case of simple irritability. The silene, the dipsacus, and the whole class of flycatchers, as they have been denominated by botanists, equally evince this property.

It will be readily conceded, that where a common sensory exists, it is reasonable to infer, that sensibility is a property of such a being. In all animals possessing a sensorium, the voluntary motions are commenced, suspended, renewed, continued, or accelerated by an act of the sensorium conveyed by the interposition of the nerves to the muscles of voluntary motion. It will also be acknowledged that the excitement arising from internal feeling, manifested by voluntary motion, exhibits evidence of a sensorial power not to be invalidated. I shall therefore endeavour to make it appear, by facts, sufficiently numerous, that voluntary power is also predicable of vegetables. Though I would not be understood to advance the assertion, that the phenomena noticed are strictly acts of volition, but in as much as they are not influenced by any known external stimuli impressed, we contend that they furnish at least presumptive evidence of excitement from internal impulse. That by a certain sensation a wish or desire is excited in the vegetable to perform a particular act. It may be illustrated by the facts observed in the gloriosa, in the season of the year when sexual appetency is indulged. At this period the stile of this plant is bent at a right angle from the very base, for the evident purpose of bringing the anthers and stigmas together. In the saxifraga, and the parnassia also, the stamens successively lean over the stigma, and retire after they have deposited

their pollen. The hedysarum gyrans, a native plant of Bengal, commences, discontinues, retards, or accelerates the motions of its leaves at pleasure. These motions it performs independently of any external agents, in the stillness of a calm, and the absence of light. The inferences to be drawn from these facts do not require any metaphysical aid to render them more intelligible.

MANY similar proofs might be adduced in corroboration of this hypothesis, but I do not wish to add to the length of these remarks, the additional burden of a multiplicity of examples. It is impossible to dismiss them, however, without observing that many motions of plants have the *appearance* of being excited by the feelings of desire, aversion, and want. By the agreeable stimulus of light and warmth, the daisy, the sun-flower, the marigold and whole fields of clover regularly turn their front to the sun. If we place the leaves of a plant in an unnatural position, they instantly reassume their original situation, as if incited to it from the painful feeling of an unaccustomed condition. They are also seemingly impelled by the feelings of hunger and thirst to multiply their means of gratifying their appetites, by sending out their roots in all directions to search for food. We daily see the roots of pines, which grow on bare rocks, descending, and extending themselves to reach the soil below, or suddenly turning into the crevices to seek for nourishment

there. We would further remark that vegetables are sensible to the enjoyment of sleep.—These nsitive plant, the tamarind tree, and many other plants, close their leaves at a certain period of the day, and open them at another regular period. Plants are sensible also to the effects of cold and darkness, and at their approach close their leaves and their petals.

If, from these cursory observations on the analogous functions and vital properties of animals and vegetables, in which we have endeavoured not to degrade the one, nor too much elevate the other, it is reasonable to believe, that sensibility exists in the myriads of insects, whose existence is limited to a day, who flit in a sun-beam and are seen no more, will it be absurd to hope, that it also exists in the majestic oak, which defies the tempest, and whose age is protracted to a thousand years?

In concluding, gentlemen, this parallel description of the characteristics of animal and vegetable life, which has been but too rapidly sketched, I would remark, that it was not attempted with any expectation of fixing the boundary, which marks the line of distinction between the two kingdoms. In prosecuting the undertaking, I confess as sincerely as gratuitously, that it was impossible not to feel an anxiety arising from a conscious inability of giving the subject that interest which its importance demands.

It cannot most assuredly be contemplated with indifference; and perhaps the oftener it is reviewed, the more extended will be our knowledge of those laws, by which the author of Nature regulates the operations of animated beings. But however limited and imperfect may be our present views of creation, to a benevolent mind it is, and must be, a constant never-ceasing source of consolation to reflect, that "all nature teems with life;" and to the humble and devout, one of his noblest employments, to

"Look through Nature up to Nature's God."

THE END.