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ARTICLE III.

ERASMUS DARWIN.

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ERASMUS DARWIN was born in Nottinghamshire, England, in 1731. Educated at Cambridge, and pursuing medical studies at Edinburgh, he began the practice of medicine at Lichfield, in Staffordshire, in 1756. Married in 1757, he was left a widower in 1770, with three sons. The eldest, Charles, gave great promise of brilliant talent, but died early in life from a wound received in dissecting; the second, Erasmus, Jr., showed no taste for science, and died a bachelor; the third, Robert Darwin, became a distinguished physician. Eight years after the death of his wife, Dr. Darwin fell greatly in love, at first meeting, with Mrs. Pole; but as Colonel Pole was living the passion was only allowed to exhale in gallant verses to one whom he called "doomed forever to another's arms." The "forever" lasted, however, only about two years, when the Colonel died, and Darwin laid suit in earnest. Mrs. Pole consented, but on one stern condition: the doctor must leave Lichfield. He married her in 1781, and moved to Derby, where he remained happily with her until his death in 1802. During the twenty-five years' residence in Lichfield he drew about him some distinguished admirers and friends; among them Thomas Day, the author of Sanford and Merton, and Richard Edgeworth, the father of his more celebrated daughter Maria.

His fame and skill as a practising physician were very great; and his treatment of diseases is, I understand, acknowledged by the best physicians of to-day to have been judicious and energetic. It was only in the reasons he gave for his action that he failed. He placed the greatest re-

liance upon diet and regimen. Good beef, mutton, and poultry, milk and fruits; great abstemiousness in fermented liquors, and total abstinence from distilled; plenty of out-door exercise, and well ventilated rooms within; these were his very sensible hobbies. Undoubtedly some of his fame was due to the personal attractions of his character. Although inclined to be somewhat sceptical in religious matters, he was always decorous and respectful in speaking of the opinions of others; and he showed many of the best virtues of a Christian character. His omnivorous appetite for knowledge, the fruitfulness of his fancy, the playfulness of his irony, made him an agreeable companion; his great taste for botany and landscape gardening were indulged upon his grounds; and the hospitality of his house increased the attraction. Naturally somewhat clumsy in his appearance and movement, his awkwardness was increased by his breaking his knee-pan on occasion of one of his tumbles from a grotesque sulky of his own contrivance. But neither his lameness, nor the deep pits left by the small-pox, nor his inveterate stuttering created any repulsion that could long weigh against the attraction of his kindness, his learning, and his wit, the solidity of his sense, and the playfulness of his nonsense.

During many years, from 1771 to 1794, he labored upon a work called "Zoönomia; or, the Laws of Life." Before he gave it to the press, however, he wrote a poem called the "Botanic Garden." It was begun, Miss Seward tells us, about the year 1779, that is, soon after the time when he first met Mrs. Pole. He had purchased a fine location near Lichfield, and laid it out as a garden. This gives the title to the poem, which consists of two parts—first, the economy of vegetation; second, the loves of the plants. This second part, which is lighter and more playful, was published first. The plot is exceedingly simple. The Goddess of Botany (described in the first part) having retired, the Muse of Botany steps forward, and enumerates to the listening sylphs and gnomes various plants and flowers; describing each plant as a beautiful woman, attended by as many adoring

lovers as the flower has stamens; or (if the plant has more pistils than one) as two or more females, attended by their appropriate number of males. The description by the muse being ended, the sylphs and gnomes retired; and Night, creeping up on tiptoe, bade the nightingale repeat the strains.

The plot of the first part — the economy of vegetation — is equally simple. The Goddess of Botany descends to the garden; and the gnomes, nymphs, and sylphs receive from her their orders, in what way to bring forth the flowers and fruits in their season. Having given the commissions, the goddess takes to her chariot, and is borne by the zephyrs to the clouds.

Each of the two parts is divided into four cantos, and the whole poem comprises four thousand four hundred and twenty-two verses. The versification is smooth — in fact, too smooth; its melody becomes monotonous. It contains very numerous short passages of great beauty; but the want of plot or connection makes the poem, as a whole, more unreadable than the Paradise Lost. It is rather a collection of exquisite passages than a poem. Its main use, evidently, was to give an opportunity for the notes, which are full and rich beyond description; embracing curious dissertations and observations on almost every possible subject of physical science, with not a few on metaphysics, aesthetics, and theology. It is evident, from contemporaneous writers, that the notes did much toward giving the volume its high popularity immediately upon its publication.

The subsequent volumes in prose, upon Zoönomia and upon Phytologia, have the same character as the notes to the Botanic Garden; they are a thesaurus of curious observations, experiments, and speculations upon the higher regions of physical science — the regions where it borders upon psychology and metaphysics. The doctor's style is very clear, both in the prose and in the poetry; he could be understood by all readers; and as his reputed scepticism nowhere appeared in his writings, he was offensive to none.

William Cowper and Maria Edgeworth joined in his praise. In the first American, from the fourth London, edition of the Botanic Garden, are several poems, both in English and in Latin, bearing tribute to him. He was compared to Newton in science, and to Milton in the poetic art; and the Zoönomia and the Botanic Garden were presumed to be about to become in future times among the great sources of English honor.

My father's copy of all these volumes has recently come into my possession, and as I look over the pages I not only find his pencilled annotations, but recall my own childish judgments upon various passages. I clearly remember standing analyzing the beauties of a landscape, and comparing it with Darwin's theory of beauty; and I know that I never stood on that spot after entering my thirteenth year. On re-reading the volumes, I am convinced that I must have read the whole several times before that date, else I had never held the contents so clearly in my memory these eight and forty years. I am surprised to find how large a portion of my general information I had thus gained in my childhood, through the clear and attractive style of this physician at Lichfield.

This re-reading of the grandfather's books has also explained to me why Charles Darwin's recent speculations have had so much less interest and less fascination for me than for many of my contemporaries. The fact is, I had had Darwinism so thoroughly in my boyhood that it is difficult for any amount of exposure to induce a second attack. The writings of Darwin and of De Maillet, with both of which I was familiar at that time, contain the fully formed germs of all the modern theory.

In the first volume of the Zoönomia the author endeavors to discover a few general laws ruling in vegetable and animal bodies, as attraction, cohesion, repulsion, etc., rule in physics. He does not, however, do this in any materialistic or atheistic spirit. On the contrary, he expressly recognizes, and that repeatedly, the necessity of attributing to organized beings

some immaterial entity governing them; the necessity, also, of assigning wisdom and love to the First Cause of the Universe. He asserts that his view of the reign of law in the development of organized beings gives us a higher conception both of the wisdom and power of God.

First of all, he endeavors by a great variety of ingenious experiments, as well as arguments, to show that every sensation is a movement of the nerves, or of the nervous system; and secondly, that all ideas and volitions are a reproduction of the same or similar movements. In this reproduction two great laws operate — the law of imitation and the law of catenation. The irritation of the nerve produces contraction; the contraction, sensation; the sensation, desire; the desire, volition; volition produces muscular contraction; but all these links are either successive imitations of motions, or else reproductions of motions through association.

"All diseases," says he, "originate in the exuberance, deficiency, or retrograde action of the faculties of the sensorium as their proximate cause, and consist in the disordered motions of the fibres of the body as the proximate effect of the exertions of those disordered faculties. The sensorium possesses four distinct powers or faculties, which are occasionally exerted, and produce all the motions of the fibrous parts of the body. These are, the faculties of producing fibrous motions in consequence of irritation, which is excited by external bodies; in consequence of sensation, which is excited by pleasure or pain; in consequence of volition, which is excited by desire or aversion; and in consequence of association, which is excited by other fibrous motions. We are hence supplied with four natural classes of diseases, derived from their proximate causes, which we shall term those of irritation, those of sensation, those of volition, and those of association."

Such is the simple basis of Darwin's Zoönomia. In elaborating and defending this classification his method is not so simple. Occasionally he speaks like a transcendentalist; generally, like an empiricist. But his definitions are

so peculiar that it is hard to decide whether his thought was clear or not. For example, he says: "The word 'sensorium' in the following pages is designed to express not only the medullary part of the brain, spinal marrow, nerves, organs of sense, and of the muscles, but also, at the same time, that living principle or spirit of animation which resides throughout the body, without being cognizable to our senses, except by its effects." He goes on to intimate that perhaps the brain is a gland, separating from the blood a fluid more subtile than the electric aura, to be used in thought and sensation, but does not intimate any hypothesis as to the manner in which this fluid is used. Consciousness, he tells us, is a voluntary attention to remembered sensations; identity is a memory of past consciousness; free-will is a voluntary attention to particular links of catenated motions, which have arisen to recollection independently of our volition.

He argues at length, out of the affluence of his knowledge of natural history, to show that instinct, whether in man or animals, differs only in degree, not in kind, from acts of deliberate will and forethought. In the course of this argument he takes up the natural language of the passions, and endeavors to show that the natural signs of emotion are the result of association with the earliest actions accompanied by such emotions. Tears, for example, spring from intense feelings of pleasure, gratitude, or love; and the cause is gravely stated to be that the titillation of the olfactories of a new-born babe by the odor of the mother's milk excites tears and produces pleasure, thus associating the two forever. Again, when the baby is satisfied, the sphincter of the mouth, fatigued by sucking, is thoroughly relaxed, and the antagonist muscles mechanically produce a smile; whence smiling is forever associated with satisfaction and serene pleasure. These two examples, out of nearly a score, are sufficient to show the manner in which he reduces mental and aesthetic phenomena to the association of ideas in infancy. Even the first action of the new-born animal he explains by pre-natal

associations. The expression of music or the beauty of proportion in architecture he regards as wholly conventional — the result of purely arbitrary associations. Abstract ideas he declares to have no existence, even in the mind of a metaphysician, who mistakes an imperfect idea of an individual for a general idea.

Motions are declared to have a propensity to repeat themselves, and to awaken imitations of themselves in other parts of the body. This point is illustrated by small-pox. When variolous matter is introduced under the skin by a lancet, there is no virus introduced into the blood, nor anything analogous to the introduction of spores into a seed-bed; the introduced matter simply excites peculiar motions in the skin about the wound, and these motions are repeated by morbid imitation in other parts of the system. We must not, however, suppose that Darwin had risen to the conception that all phenomena of matter are simply modes of motion. Had he done so he would not have argued, as he does, to prove that in inoculation there is no conveyance of virus.

The section upon the circulatory system contains several highly characteristic speculations. All secretion of glands, he thinks, probably produces pleasure to the embryo; and it is not until after birth that part of them begin to act without our consciousness. In speaking of digestion he narrates a case in which the patient had eaten game that was too "high," and the system ejected it with such vigor that the action of the whole system was inverted; the skin rapidly absorbed moisture from the air, whence it passed into the stomach, and so came out of the mouth; and this state of retroverted motion continued until several pints of water had been thus absorbed from the air and ejected by vomiting.

He defines temperaments to be permanent predispositions to certain classes of disease. The temperaments are four — decreased irritability, increased sensibility, increased voluntarity, and increased association.

The basis of his classification of diseases has already been

given in his own words. His first class consists of diseases of irritation. In his preliminary discussion he advances the opinion that the varying solar and lunar attractions which cause the diurnal and monthly variation of the tides cause also more or less distinct tendencies to periodicity in every animal function, whether in health or in disease. In discussing his second class — diseases of sensation, he renews his thesis that in some kinds of contagion the disease consists in morbid motions of "the fine extremities of the capillaries or glands," which are propagated by morbid imitations of the motion. One of his arguments to prove this is the occasional suspension of one such disease by another. He argues that if the contagion was a virus the two diseases would proceed *pari passu*. The fact that one waits for the other proves to him that each is but a morbid habit of motion. The third class of diseases are those of volition — meaning by volition or voluntary motion not only movements of conscious volition, but involuntary motions whenever they arise as if it were from a motive. His fourth class is diseases of association, that is, from sympathy or consent with parts; as a chill of the skin producing cholera; diseased liver, the gout; or wetting the feet, coryza.

The closing section of his first volume is upon generation; and it introduces all the main doctrines which by their expansion have rendered his grandson so famous in our days. The variation of species under cultivation is dwelt upon with emphasis, as also the survival of the fittest, and the consequent improvement of the species; and it is asserted that all the great variety of creatures has been produced by the perpetual endeavor of the animals through so many generations to adapt themselves to their surroundings. The whole of his argument is, however, based upon the doctrine that the embryo is at first a living filament, secreted from the blood of the male parent. This living filament has the four fundamental capacities of organic matter, viz. capabilities of irritation, sensation, volition, and association; and it also has acquired habits of motion or thought derived from the

life of its immediate male ancestor, and perhaps from millions of antecedent generations. These habits modify, to a certain extent, its growth and development. Moreover, the movements of the brain going on in the thought and imagination of the male parent at the moment when the filament is secreted from the blood are imitated in the filament, and farther modify its development. By this differentiation in the act of generation the living organism has gradually assumed new forms in multiplied variety.

"Would it be too bold," he asks, "to imagine that in the great length of time since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, — would it be too bold to imagine that all warm-blooded animals have arisen from one living filament, which the great First Cause endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end?"

After this passage, he further argues that all the lower orders — fishes, reptiles, insects, worms, sponges — may have sprung from the same filament. Finally, he declares that vegetables are also to be enumerated among the lower orders of animals, and that they have produced all their own variety by the survival of the fittest in their perpetual contest for light and air, food and moisture. These ideas he ascribes to ancient philosophers, and also to David Hume. "Shall we conjecture," he asks, "that one and the same kind of living filament is, and has been, the cause of all organic life?" This he thinks the grandest conception of the creative act. "For," he remarks, "if we may compare infinities, it would seem to require a greater infinity to cause the causes of effects than to cause the effects themselves." And again, "As every cause is superior in power to the effect, so our idea of the power of the Almighty Creator becomes more elevated and sublime as we trace the operations of nature

from cause to cause, climbing up the links of these chains of being, till we ascend to the great source of all things."

Doctor Darwin closes his first volume with a paragraph containing these words: "Had those ancient philosophers who contended that the world was formed from atoms ascribed their combinations to certain immutable properties received from the hand of the Creator (such as general gravitation, chemical affinity, and animal appetency), instead of ascribing them to a blind chance, the doctrine of atoms, as constructing or composing the material world by the variety of their combinations, so far from leading the mind to atheism, would strengthen the demonstration of the existence of a deity. 'The heavens declare the glory of God, and the firmament showeth his handiwork. Manifold are thy works, O Lord; in wisdom hast thou made them all.'"

The second part of the Zoönomia is occupied with an enumeration of diseases, classified on the above principles, illustrated by brief reports of cases, and with suggestions as to their medical treatment. All diseases are morbid motions, and are divided into four classes, as those motions are irritative, sensitive, voluntary, or associative. The four classes are divided into eleven orders, founded on the increase, diminution, or inversion of the motion. The eleven orders are divided into forty-one genera, thirty-seven of which are founded on the part of the system affected, the other four on the fundamental classification. Nothing could have a more admirable simplicity upon paper; and we must pardon those who hailed it with the enthusiastic faith that the Newton of morbid physiology had appeared in Erasmus Darwin.

But why has it now been forgotten? In answering this question, I can speak only as a layman, without special medical education. A true system of classification, in any subject whatever, may be attained, by carefully following either one of two roads. The first and surest groups carefully the individuals into species, then the allied species into genera, and so on ascending. This is the surest method, because the mind while travelling in it has only need of surveying

carefully the ground immediately before it; and there is comparatively little danger of overlooking essential facts. It corresponds to the synthetic method in geometry; it is the inductive method of Bacon. The other method begins by taking a sweeping bird's-eye view of the whole field; from that rapid and extensive glance makes first the larger divisions, then the smaller ones, and finally separates the species. This method is more rapid, but is less sure. It requires a much wider grasp of mind. It is Bacon's deduction, and is very apt to fail, unless it is performed by a man of rarest genius, or else has been silently preceded by the labor of the first method.

Now the classification of the Zoönomia seems to me to have proceeded by this second method. It looks precisely as though Darwin had determined, on *a priori* grounds, that the laws of organic life must have a simplicity like that which Lavoisier had just introduced into chemistry, and that therefore he had evolved this system of forty-one genera "out of the depths of his inner consciousness," and then arranged his diseases under it. I do not say that this was Darwin's mode of procedure; nor will I deny that the mode, if adopted, might, in the hands of a man of rare genius, be successful; but the test of the system is to be found in the examination of the species. Can the varieties of disease be naturally arranged as species under these genera? Will the system be found, as Darwin evidently believed, a guide to a natural therapeutic treatment? These questions can be answered very readily.

Look, for example, at diseases which consist in retrograde irritative motions of the alimentary canal. Nothing can be simpler and more natural than that definition of a genus. It is one of Darwin's best. He divides it into eleven species; but it appears to a lay reader that they are not eleven species of one genus, but simply eleven cases of a similarity in one symptom. Three of the eleven are cholera-morbus, hysteria, and hydrophobia, which surely are not to be considered related simply because in each there is a sort of retrograde motion of a part of the alimentary canal.

In his preface the doctor adopts the words of Cullen, that "the essential characteristic of a disease consists in its proximate cause." He declares that his classes are founded on the proximate causes, the orders on the measure of the cause, the genera upon the proximate effects, the species upon the locality. That is to say, then, the proximate cause of hydrophobia is the irritability of the human system; the order under which it falls is determined by the irritation producing inverted motion; the genus is decided by that inversion of motion being in the alimentary canal; and the specific mark of hydrophobia is that the inverted motion is in the oesophagus only. Very ingenious, but not peculiarly satisfactory; it would scarcely enable a young practitioner to identify a case of that terrible disease; and an unlearned man, listening to the discussion of the causes and symptoms of hydrophobia, might be excused for asking what part is played by the bite of the mad dog, and of what is the shuddering at water a symptom. Another genus in the Zoönomia contains fifteen species of diseases, beginning with winking and ending with external parasites. Again, the genus of decreased irritative action of the sanguiferous system includes, among its seventeen species, fainting, menorrhagia, and scurvy.

It must be acknowledged that objections may be raised against every truth; but, on the other hand, an ingenious man can bring facts to sustain any theory. Cicero affirms that no proposition can be invented so absurd that some philosopher has not already seriously maintained it. It does not follow that mankind is incapable of attaining truth; but it does follow that we should examine both sides, and examine with care; we must not suffer "the gaps in our knowledge to be filled with loose and unfounded speculations." This appears to me to be the fault of Erasmus Darwin and of that school of writers with which he is naturally affiliated. It would not be at all strange if his classification of diseases should be revived and made the foundation of a new school of medical practice. The great *éclat* with which his grandson has revived and expanded the speculations of the grandfather

upon evolution would be a valuable advertisement for such a medical school. Nor would this revival of the erroneous theories of the Zoönomia be an unmixed evil; for there are many important truths and fruitful suggestions in the volumes. Moreover, the revival of Dr. Darwin's manifestly erroneous nosology and therapeutics might lead some enthusiastic admirers of his doctrines of evolution to look more narrowly at the evidence, and see whether there also some loose and unfounded speculations may not have crept in. It is undoubtedly true that Darwin's nosology may be wrong, and his view of evolution correct; yet in the Zoönomia the fundamental principles of his classification of diseases are so closely interwoven with his views of the gradual transformation of species, that we cannot help suspecting the latter to have also errors in its foundation.

The great *a priori* argument of the elder Darwin is ignored by the younger; and indignantly repudiated by many of his followers. Yet that argument remains to-day the strongest argument in favor of evolution; it is analogous, if not identical, with Maupertuis's grand theological dogma of the least action. It is more consonant with our conceptions of infinite wisdom and infinite power to suppose that the first race of creatures were made capable of evolving all subsequent races. The law of parsimony requires us to make that hypothesis; provided that hypothesis is possible, and is sufficient to account for the facts. But even if evolution is possible, there may be various modes of effecting the evolution. Different scientific romancers have imagined different ways — some natural, some miraculous, some very slow, some very rapid. The debates of modern scientific associations in their sections of natural history remind one, by the fertility and wildness of imagination displayed, of the debates of the schoolmen in the Middle Ages. Dr. Darwin and Charles Darwin suppose the forces of evolution to have been exceedingly gradual, occupying countless millions of ages. Both these writers are men of wonderful learning, of evidently attractive personal character, and express themselves in a clear and taking style. The

one created a furor at the close of the last century; the other, a wider and wilder furor now. Yet their doctrine that the transformation of one species into another has been by an exceedingly slow and gradual process is encompassed with many difficulties; and the two facts relied upon as its principal supports seem to me completely illusory. The first of these facts is the variability of species. By domestication and culture and by variation in natural surroundings the offspring of one original parent are observed to become very different in character. The second fact is, that the species and genera frequently appear to shade into each other; between any two forms, however closely adjacent, we can, if we have a sufficient number of specimens, find intermediate forms. This is the second of the cardinal facts on which the superstructure of Darwinism rests. Now, I do not deny the possibility of the truth of Darwinism; but I say that these two facts are not conclusive, even as proof of the transformation of species, much less, of their gradual transformation.

Organic beings are primarily distinguished from each other by their forms in space; the classification of them by naturalists depends upon their variations of form. The classification of organic beings is a question, therefore, of geometry, and is to be criticised by geometric canons. All physical investigations, indeed, must ultimately be brought under mathematical law; since they all investigate phenomena of space and time, and are to be dealt with only by virtue of our ability to reduce them to symmetrical conceptions of space and time, that is, to treat them as the embodiment of mathematical functions. Whatever be the efficient cause acting to determine the form of a nascent embryo, and however much its action may be modified by circumstances, it shows to the careful observer at least a tendency to act according to precise geometric law; and had we sufficient knowledge and sufficient analytic skill, the mathematical equations of vegetable and animal forms could be given precisely as the equations of crystalline forms have been given. Instances of this have already been shown in the law of

phyllotaxis, and in the reduction of the earliest forms of embryos to analytic equations.

I am not, therefore, about to be illogical nor unreasonable, in taking a geometrical illustration to show the fallacy of arguing for evolution from the variation of species and from the insensible gradation of forms. It will not be arguing from analogy, but only taking a simpler example in the very same problem. Geometry and morphology are alike a classification of forms in space. Let us consider, therefore, the possible variations of an ellipse. It may vary *ad libitum* as to the scale on which it is drawn — from the stellar orbit to that of a vibrating atom. It may also vary without limit in regard to eccentricity — even inverting itself, and becoming a hyperbola. But, start with the conception of an ellipse, and you cannot make it become anything else whatever than a conic section. Its variations seem, in certain directions, unlimited; but in other directions it has no power whatever to vary. The same is true of every other curve. All curves have a great flexibility or power of variation in certain directions; while in other directions they are absolutely fixed. It is, therefore, probable, *a priori*, that species and genera, which like curves are to be defined by laws of space, have the like elasticity in some directions, the like rigidity in others. We have no right to assume that any species may vary into any and every other species. We have no right to assume that a genetic connection with a common ancestry can be traced, even in thought, between two species taken at random; for such connection cannot be traced between two curves taken at random.

Now, let us take any other curve than the ellipse — an elastic curve, for example. The elastic curve may simply wave, or its waves may rise until they interlap; they may all be compressed into a figure eight; they may revert into kinks; they may revert into one single loop or kink; they may roll like epitrochoids; the rolls may tighten into a circle; and this circle is perhaps indistinguishable by the microscope from the circle formed when the eccentricity of the ellipse becomes zero. Darwinism might say, Here the ellipse runs

into the form of a circle, there the elastic curve runs into the form of a circle, and the highest power of the microscope shows no difference in those circles; the ellipse and the elastic curve are therefore one. But the geometer replies that it does not follow. I apply the microscope of the calculus, infinitely more powerful than your best Tolles, and find the circle of the ellipse to be a single line, while that of the elastic curve is an infinitely multiple one; the one form cannot pass into the other.

It appears to me that, in like manner, one who has an intimate knowledge of organic life might answer the argument for the common descent of two genera based on the occurrence of intermediate forms insensibly bridging the chasm between them. The future botanist may point out distinctions between species and genera which now seem to run together. Even at present, common sense and common knowledge distinguish infallibly between things which no scientific investigation can distinguish. For example, no man in common life is at a loss to decide whether a given fruit is a plum or a cherry; yet no botanist can define the difference between the two. Nor can the botanist readily describe the difference between oaks and chestnuts, and yet every woodman knows it. If there is really a difference between them to-day, surely the difficulty of defining it does not show that it formerly did not exist.

The value of Darwinism as a mnemonic and as a guide to the investigation of the affiliations of organic beings is acknowledged. But the value arises from its assumption of evolution, much more than from its assumption of that evolution having been through insensible variations; and this peculiarity, which distinguishes Darwinism from other forms of the doctrine of evolution, seems to me a source of very serious danger to one who is seeking the truth, and who wishes to see the highest and the widest truths. The discrimination of differences is really the most important function of intellect, and is to be jealously guarded against any usurpation on the part of its companion power — the

power to perceive likenesses. The mode in which Dr. Darwin's philosophy leads to this danger will be seen by considering his treatment of beauty. That he had the sense of beauty is shown by many of his writings; but when he undertook to set forth an explanation of our sense of beauty, he was so eager to reduce all the phenomena of consciousness to his four laws of irritation, sensation, volition, and association, that he made beauty wholly subjective, wholly dependent on association. He denied the existence of harmony or proportion either in space or time. All the pleasure which we feel in hearing music, or in looking at buildings, statues, pictures, landscapes, he resolved into the pleasure of association with the earliest gratifications of the senses.

Yet it has been securely established, by experiments and investigations made with the utmost care, that the sense of beauty does not arise from arbitrary associations in the mind of the percipient, but from what paradoxically may be called an unconscious perception of something in the object itself. In beautiful colors, beautiful tones, beautiful harmonies, beautiful figures, it is discovered that the predominant ratios of times and spaces generally involve only the four first prime numbers 2, 3, 5, and 7. The beauty of an object is in proportion to the simplicity of the law governing the combinations of these four numbers, and also to the multiplicity of the results arising from that combination. In phyllotaxis, for example, we have this exceedingly simple law, that the space between two successive leaves divides the whole space around the stem in extreme and mean ratio. The law involves numerically only the primes 2, 3, and 5, but involves them in such a form that it is not cognizable by human senses. In the actual embodiments, however, of the law in the vegetable world, both the angle of successive leaves and our sight of it are subject to interferences — interferences which make the law cognizable by the sense of beauty in all the endless variety of the forms of sea-weeds, lichens, mosses, flowers, shrubs, and trees.

Another example may be found in music, which Erasmus

Darwin distinctly says pleases only by arbitrary association. Yet the mathematical analysis of music is complete. In its rhythm the simplicity is so great that no other prime numbers are introduced from the division of measures up to the arrangement of movements than 2 and 3; and yet the variety of rhythms is innumerable. In the harmony of chords two additional primes, 5 and 7, are introduced. Now, the harmony of different ages and of different nations varies; but in the most cultivated and musical nations there has been a steadily growing inclination toward a certain style of harmony; and on a careful analysis of the numerical relations in the various styles, it is discovered that the musical instinct has not been at fault; it has steadily gone on, dropping that which can be shown to be arithmetically less perfect and clinging to that which is arithmetically more perfect, to that which keeps in prominence the simplest primes, 2, 3, 5, and 7, but combines them in the greatest variety of combination. Alexander Pope thought it

> "Strange that such difference there should be
> 'Twixt Tweedle-dum and Tweedle-dee!"

And Erasmus Darwin said there was no difference; but modern physics and modern music show that the difference between styles of music is as real and immutable as the difference between an ellipse and an elastic curve.

Charles Darwin seems to me to be saying to botany and zoölogy precisely what his grandfather said to music and architecture, and to be just as deeply in error in saying it. If music depends for its expression, as Dr. Darwin thought, simply upon accidental association of ideas, — so that "Batti, batti," may just as well be called and sung "Gently, Lord, oh gently lead us," in a community ignorant of its origin, — then music is unworthy of the high devotion paid to it by those who, with Wagner, esteem it the most direct, truthful, and powerful of all the modes in which the human soul can utter its deepest self; nay, it is unworthy of study by any serious, earnest man. But in this case the mathematician has come to the aid of the musician, and

demonstrated that the fashions which have gradually become antiquated in music have mathematically deserved their failure; and that the modes which have increased in favor among earnest, cultivated people have a demonstrable mathematical superiority, which in all probability is the cause of their aesthetic conquests.

And if the species and genera, families, orders, and classes in the organic world have been produced as Charles Darwin says, through the gradual variation of the species, and survival of the fittest, — the whole being the present accidental and still slowly shifting result of an accidental balance of forces, — then the classifications of organic beings is unworthy the labor bestowed on it by such men as Aristotle, Linnaeus, Cuvier, De Candolle, and Agassiz. If the evolution of the species (granting there has been one) has taken place in the Darwinian method, then the labors of these naturalists become as worthless as the conversation between Polonius and Hamlet on the shifting form of a cloud. Fortunately, for the interests of truth and of man there are instinctive faiths in our intellect, which the sophistry of our reasoning never destroys. Could we, as modern Darwinism bids us do, destroy our faith in the real existence of order, symmetry, plan, in the universe, we should also destroy all interest in studying it; the study of nature would become then a mere amusement like the finding of profiles on mountain crags, or of faces in the crowded petals of a rose. The best students of natural science have believed that the distinctions in nature are real, and sharply defined, even where we fail to discover the line; and that their work was discovery, not invention; they have agreed with the Hebrew Psalmist, rather than with Comte concerning the language of the sky.

And as the mathematician has brought demonstration to the aid of aesthetics in music, so shall he in the future bring demonstration to the aid of the naturalist who reverently believes that in his essay at classification he is partly decypher-ing and reading a divine plan of infinite simplicity in its

apparent complexity. As Erasmus Darwin was mistaken in supposing that harmony of proportions and tones is dependent on accidental associations of ideas, so Charles is mistaken in supposing that the harmony of organic forms is dependent on accidental associations of circumstances. The beautiful harmonies of music, and of coloring, and the beautiful proportions, not only of temples, but of plants and animals, arise from the fulfilment of simple numerical relations; in that particular modern investigations confirm the prophecies of Pythagoras.

The mathematical student believes that the organic worlds are built upon simple original formulae, which admit of an immense variety of definite changes. He looks for the day when the botanist and geologist, having drunk deeper draughts from the Darwinian spring and become sober again, shall discover and define more sharply distinctions between forms which they are now confusing. He trusts that the mathematician will finally be able to discover simple equations which will express by changes in the constants, the varieties of organic forms. The first steps towards such mathematical natural history have already been taken by Peirce in his Lectures on Analytical Morphology.

Dr. Darwin's theory of evolution was closely connected with his scheme of classifying diseases; the most signal defect of that scheme was its failure to recognize any other differences than differences of degree. There was no sharpness of definition anywhere. It is, I confess, patent to every eye that some disorders in the human system have this indefinite character. There seems to be no dividing line between the highest state of health and complete disorganization and prostration; the one runs into the other more gradually than the oaks into the chestnuts. But, on the other hand, there are, certainly, some diseases which are sharply defined. The modern microscope, modern chemical reagents, and the modern spirit of experimental science are producing indisputable results in this field. The revulsion from Darwin's method of classifying diseases will, we think, be followed by revulsion from its method of classifying organic beings.

The first duty of every student, and of students of the natural sciences as well, is to seek for the truth, wherever it may lie. That the student may also be assured that the truth is always more likely to be found by one who seeks it with reverent awe; by one who, rejoicing in that which he has been permitted to unfold, remembers also that, in the words of Emerson, "Nature never became a toy to a wise spirit." The higher one's aim, the higher is likely to be his attainment; and no aim can be higher than the aim reverently to read, gratefully to obey, the teaching of the Infinite Spirit which framed the worlds.

ARTICLE IV.

SUCCOTH AND PENUEL NOT YET IDENTIFIED.

BY PROFESSOR J. A. PAINE, PH.D.

AN identification of Succoth and Penuel published in the Bibliotheca Sacra for October last ought not to pass without review. An obligation, perhaps, rests upon every one specially informed on the subject, to apprise biblical students whether the opinion therein expressed can be relied upon or not. Having thoroughly explored every portion of Eastern Palestine from the Arnon to Damascus two and three years before Dr. Merrill's observations, and now having given four years of study, aided by every work of reference that could be desired, to its geography and places in a biblical point of view, I might be expected to judge intelligently respecting the merits of this proposition. Though extremely reluctant to speak adversely to any proposal he may make, I am compelled to dissent from Dr. Merrill's view for many reasons, among others the following.

General Considerations.

1. The topographical character of the valley forbids it. From the point where the Zărqâ approaches the region of