Original Communications.

ON THE PHYSICS OF DISEASE,

AND THE PHYSICAL PATHOLOGY OF THE BLOOD.

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Prefatory Note.

To the Members of the British Medical Association.

Gentlemen,—The following series of papers is based on a paper of which I had given notice to the Cambridge meeting, entitled "The Physical Pathology of the Blood". Owing to the pressure of business at the meeting, the paper was only given in very brief abstract; but as many of my Fellow Associates have done me the honour to express a wisa to see it *in extenso*, I have undertaken to send it to press in the columns of the Journal, and have added some additional matter, which may, I trust, prove of interest. The object of the communication is to show the relationship that exists between physiology, in its more advanced form, and daily practice; and specially to simplify the structure of scientific medicine by indicating that disease, in however many types it may appear, is but one departure from a natural condition; that, in brief, as I expressed ten years ago: "Disease is an unity with a variety of phenomena; and the causes of disease are reducible to a few elementary forms."* I shall endeavour to illustrate this more definitely than I have yet done; I shall try to show that life in its physical aspect—for I have nothing to do with metaphysics—is force developed through matter, and from that I shall strive to explain some of those changes—symptoms—diseases, if we must call them so—which follow when the expression of that force is disturbed, by reason of any change in the nutrition of the body or in the mechanism of the body. I shall thus embrace, and I think properly, under the head "physics", every physiological act, whether that be the contraction of the heart, the circulation of blood, the oxygenation of the blood and tissues, secretion, or any other act which we are accustomed to connect with the thought of life.

Such is the outline of my plan; but ere it is opened let me crave the indulgence of the large, the critical and learned, audience to which the plan is submitted. The ground to be traversed is so new, the appearances it presents are so different to those that are eft behind, and the course of description is so difficult, that every consideration must be asked with all due earnestness and confidence. I stand forth but as an explorer with one pair of eyes; and pretend not that my descriptions and inferences shall remain correct when the same objects as those upon which I have looked with the wonder of a little child who sees a new scene, shall have been investigated, discussed, and defined, by the many who follow with more ease, more knowledge, and more wisdom. I care not, in fact, if everything I say crumbles to the dust, should I succeed in drawing attention to the advanced work that is before the present generation of medical men. I have no dogmas to put forth, no opinions to offer beyond what facts support; and if I draw forth argument, why, then, as Julius Cæsar Scaliger hath it, "Sicut ignis lapidum collisione, ita ex disceptationibus elicitur veritas."

* See Introductory Chapter to *Journal of Public Health*, vol. i, page 2; January 1855.

Chapter I.

On Death or Temporary Inertia as the Extreme Form of Reduction of Animal Force, and on the Unity of the Process. On the Unity of Animal Force during Life, as mere Motion. On the Physical Origin of Animal Force or Motion.

On Death.

When a man, or other animal, lies dead, the common voice of mankind, as if instinctively governed, expresses the fact in one reasoning sentence. You ask any number of persons why in their estimate they consider the man or the animal dead? The answer will be, "Because the body has ceased to move"; or, the involuntary movements having also ended, "Because the body has ceased to breathe." It is a singular truth, and none the less a truth, that this common form of expression conveys, in what we now see to be the profoundest philosophy, the precise meaning of physical death; for death, in the physical aspect in which we are looking at it, is neither more nor less than temporary inertia, or cessation of motion. The force which kept the molecules of the body apart, and which enabled them to move freely on themselves, which enabled also certain of them to assume various mechanical forms and directions, is withdrawn; then the molecules, no longer separated, begin to come together, and the body not only is made powerless, but for a time rigid: and thus it remains until, by the setting up of new physical processes in which force is evolved, it is transformed into a new type of physical life.

But that which we designate as force is simple motion; it was motion that kept the molecules at true distance, that gave them flexibility, that limited their combinations with each other, and the cessation of which allowed them to come together, until the once flexible and tremulous tissues set like marble in one compact mass.

Do we want a visible demonstration of the influence of mere motion on organic particles, we have it in our hands. When the blood is in full and active motion through its vessels, before it reaches the extreme parts, the red corpuscles do not coalesce, but are held apart by the motion: we arrest that motion; we take a little of the moving blood, and let it lose motion on the microscope-slide; and the little particles, attracted by each other, at once come together and form rolls and columns. This is the effect of inertia, or death, of a drop of blood; but it carries with it the explanation of the whole physical phenomenon of death. Rigor mortis is the entirety of that process of which coalescence of blood-corpuscle is a part; it is molecular coalescence of all the body.

If we ask for a broader illustration, we have it in the very relation of our own bodies to the earth itself. By the force of gravitation, we are virtually chained to the earth; and we are enabled only to traverse its surface by the evolution of force, the motion that is evolved in us. Why is an emaciated man weak? He is coming under the influence of the earth, because he is not producing efficient motion. Why does

a bleeding man faint and fall? He is losing motion, or resistance to gravitation; and the earth claims him. For the same reason that the gyroscope in motion does not fall, but at rest does fall, the man in full possession of motion stands erect and moves; and the man who has lost motion lies prostrate and is still. When a sick man says, "I am weak," he expresses what is little thought of, because it is so simple; he is telling, in his own words, that the earth is fixing him, drawing him to herself as to the natural home to which his body must return when the motion, or force that is antagonistic to gravitation and with which he is inspired, shall be withdrawn. Thus, the living man is constituted on the same principle as the planet on which he exists, and is to the planet what the planet is to the sun. The motion with which he is endowed is his centrifugal force, the attraction of the earth the centripetal. Between these he moves, in his cycle, until, his own motion failing, he falls into the earth, as the earth, did its motion fail, would fall into the sun.

The process of death is unity. All terms that tend to divide it into types are false, and lead away from the truth; it is simple breakage of that physico-chemical process through which motion is elicited. You may arrest the motion of a steam-engine by cutting off air from the furnace, or by taking away fuel from the surface; you may increase the force until you tear the machine to pieces; or you may work it until its parts fall out of gear; you may, *i.e.*, choke it, bleed it, tear it out, wear it out, but, in every case, you only do one of two things—you either destroy the force that moved the mechanism, or destroy the mechanism that was moved by the force. It is precisely the same with an animal, in a physical point of view; when an animal dies, it dies either because its force is not generated, or because the mechanism is unable to apply the force that is generated; in both cases, the phenomena observed is cessation of motion, with the earth, like a great magnet, seizing its prey when the motion is withdrawn.

Death is only to be considered perfect when all the molecules of the body come to rest; when but in one part or segment of the body the motion is suspended, we have local death, which we call disease; when the circulation, motion, is stopped effectually through a limb, and the limb putrefies, we see in the same body the two phenomena of life and death, *i.e.*, of motion and inertia; it is an experiment thus made, as it were, for us. I have seen the two phenomena in a more marked degree in cases of animals where the motion has been arrested by inhalation of nitrite of amyl. In these, I have seen the right heart beating when every other muscle was in rigor mortis.

ON THE UNITY OF THE ANIMAL FORCE AS MERE MOTION.

Various speculations have at different times been put forth as to the nature of the force by which the body is animated. We have heard of vital force, nerve force, heat or caloric, and electric force, and schools have actually been formed on these terms alone. The cause of difference has arisen from the fact that the so-called forces are but varied representations, real or assumed, of one force, which is simple motion. The term vital force is the mere expression for force resident in bodies that live; in no other sense has it any meaning. It were in truth as well to speak of the decomposition of a dead body as the mortal or dead force, as it is to speak of the movements of a living body as the vital or live force. To imagine that there is in animal bodies any physical force other than pertains to all else in nature is beyond reason superstitious and absurd. What moves man moves the planet; and what moves the planet moves the sun; and what moves the sun moves all the infinite systems of suns and worlds in their courses. We cannot isolate an animal and break the immortal chain of life and being for the mere amusement of speculation about a special force in animals, as though an animal were not a part of the great whole of the universe, or as though a world in motion were not as much alive as a caterpillar or a moss. Impossible! We may then dismiss vital force as a human term to express the force, whatever that force may be, of an animal or vegetable body, because the force is shewn from or through the animal, not because it is itself specific and is not elsewhere.

We may dismiss the hypothesis of nerve-force on similar grounds; we might as well talk of blood-force or muscle-force as of nerve-force. It is true that force may be exhibited through nervous structure; but to isolate such force and say that it is specific or a peculiar force, is even worse than to speak of vital force in the same terms, because it is a more limited form of expression. When, however, we speak of heat-force, electric force, light-force, or pure mechanical force, we arrive at something more tangible, but we do not arrive at different forces; we meet only with one force—motion developing itself through matter, and seeming only to develope itself differently in its unity, because the matter through which it is developed is physically different. In the body we see motion in various forms. Primarily, in so far as the vegetative life is concerned, we have the motion eliminated by the oxidation of blood, which motion we call heat; again, we have motion eliminated through the nervous organism; next, we have it through light entering by the eye; and once more we have it as pure mechanical motion, in the vibrations of the tympanum when sound is produced, and in the excitation of the surfaces of the body, when the nerve filaments are set in action and sensation is produced. But when all these developments or representations of force are considered, they resolve themselves into mere motion, varying in intensity, it may be, but still the same. I breathe, I listen, I look, I feel, I move; the forces seem various, they are executed differently, but they are all simple motion. So by analogy, if I would set up a fire, I may proceed by different ways; I may take fire from fire—direct propagation; I may strike steel with flint—mechanical excitation; I may expose phosphorus in fine layer to the air—oxidation; I may set an electric machine to work and fire spirit, or drive a voltaic current through conducting substance, and produce a light on combination—electric chemistry; the acts are apparently different, the forces different, but they are all one and bring continuance of one phenomenon—motion.

It is out of character, therefore, to say that there are various forces in the body; but we may properly say that motion in the body is developed by modifications of process. At the same time these modifications are limited; for, excepting the mechanical vibration of the air on the ear, the mechanical entrance of light by the eye, and the mechanical influence of touch on the exposed surfaces, the motion of the body in all that pertains to its own power of action is through heat. It may be, that the motion which in all the soft parts of the body is manifested in the form of heat, is in the nervous centres and nervous system as a whole transformed into electric or thermo-electrical motion; but the precise source of the motion is unquestionably thermal, and it is certain that, unless through this process motion be universally diffused through the tissues, motion otherwise applied ceases to exert any local effect. Hence a frozen hand is indifferent to the most violent external excitation or mechanical motion; hence, although an electrical

current will pass readily enough through the nerves of frozen muscles and through frozen muscles, it fails to exite contraction in the absence of a thermal current. Heat is thus the sustaining motion of the organism; it holds all the active parts in such motion, that without undue waste they shall be ready under excitation or communication of new motion to act at once according to their functions. Heat, in other words, sustains the equilibrium of motion in animal bodies; it does not in the same direct manner as in the steam engine do everything, for, if it did, the body would cease to be self-regulating; but it keeps the body up to a given standard of motion and prepared for action. This reading of the value of heat-motion in the organism is of primary importance in the physics of disease.

The body thus prepared for action requires only for work extra motion, or, as the old men called it, "stimulus." It receives this from without and from within; from without in those external impressions wrought by light, sound, touch (all of which are motion); and from within by motion communicated from the nervous centres and cords; motion, which is itself derived from the combustion of the blood, and is therefore thermal in its origin.

Thus every stimulus is motion; motion communicated to parts ready to be set in motion. Just as an engine when prepared to start, by being charged with heat, waits only for the engineer to put on the pressure for its wheels to revolve and its movement to commence, so the body equally and similarly prepared moves, locally or generally, when new motion is communicated.

It was in failing to recognise the action of added motion, stimulus, that the theory of the *vis insita* of Haller fell short of the truth: Haller saw that in every muscle there was a certain standard of motion independent of nerve-stimulus: but he did not see that when by pricking a muscle he caused contraction, he was doing what the nerve normally did, communicating motion; and that, in fact, the movement he saw was nothing more than the propagation, or it might be said, the echo of the movement of his own hand; and not seeing this, he stopped short at the *vis insita*. On the other hand, the vibratory theory of Hartley failed, because it recognised nothing except the stimulus, or the motion from without. We have now more light; in truth, however we may differ as to the specific kind of motion in the healthy body, we hold demonstrative evidence of motion always present through heat, always universally diffused, and always passing from the body so as to be properly equalised. We hold also demonstrative evidence of motion as a stimulus, as derived from without and from within the organism.

OF THE PHYSICAL ORIGIN OF ANIMAL MOTION.

To endeavour to go back to the origin of animal motion would be to attempt the definition of a first cause. We might say that animal motion is derived from the motion of the earth, because, if the earth were to lose its two motions for the most infinitesimal period of time, all motion upon it would cease; or if its motions were quickened, all motion upon it would be proportionately increased. But admit so much, and thence the further argument: the earth derives its motion from the sun. But the sun has motion; and whence is that derived? Whence motion throughout all space? We must stop at the question. Without thinking, then, of the first cause of motion, we come to secondary causes—to those means by which the universal motion is conveyed through special parts, by which it developes itself through matter, or by which it is expended on matter; and in this field we have certain facts which are, I had nearly said, sufficient for all that we would reasonably know. We find motion coming to us directly, as in light from the sun; we find motion coming to us indirectly, as in heat derived from the sun, but elicited through the earth; and we find motion that proceeds from combination of opposing conditions on a vast scale, as in electrical storms. But more: we have illustrations of secondary causes of motion in smaller details, as in the mechanical friction of bodies, and in chemical combinations. In the animal organism, we trace the origin of the motion by which its mere mechanism is animated, in the chemical union of oxygen with carbon. The union of the air and blood is precisely to the body what the mainspring is to the watch. From the union, motion results, and is universally communicated to the organic parts; nor can there be any inertia or death while that communication continues. In addition to this—the force of evolution—the body receives motion from without, and by that means it takes impressions and assumes reason. The first is essential to any manifestation of life; the second is supplementary to the higher development of life. Without the first, an animal could not be constructed; but without appreciating the second directly, the animal may live: it may neither take in light by the eye, sound by the ear, nor sensation by the touch, and yet it may live.

The perfect organism constituted for motion from its own centre, and influenced by motion from without, remains in health so long as the forces, internal or external, are in due relation to the matter of the organism. Let the internal force be unduly raised or depressed, and the body is diseased; it is overactive, or it is inactive. Withdraw from the body the external forces, and it sinks into a machine; stun it with some overwhelming external force, and its mechanism is deranged or destroyed; it is made ill, or it is killed.

In the physics of disease, all our knowledge must rest on our correct appreciation of animal motion, and mainly of that motion which is derived from the oxygenation of blood. I shall direct attention in the next chapter to this last named point.

OBSCURE CASE OF CANCER OF THE STOMACH.

By William Date, Esq., Ilkeston, Derbyshire.

H. M., aged 55, was an unmarried woman, of small independent means, which she eked out by winding thread for the manufacture of gloves. She came of a healthy family, none of whom had had cancer. She had always enjoyed good health, with the exception of an attack which she had when about thirty-five years of age, and which lasted about a fortnight. During that time she had a feeling of weight at the epigastrium; no pain; persistent vomiting, the vomit occasionally consisting of altered blood. She menstruated with regularity until forty-three years of age. She never suffered from shortness of breath, and, in short, since the attack mentioned, her health had been good. About the beginning of August 1864, she began to have a sensation of weight and fulness at the epigastrium, coming on about half an hour after meals, which never, however, amounted to pain, and generally passed off in about an hour. Since that date, she had been gradually and slowly losing flesh. About October 15th, she began occasionally to vomit her food mixed with acid mucus. She was of rather a penurious disposition, and therefore, although she was much distressed by the vomiting (which for the last few days had been persistent), she did not seek medical assistance until Oct. 21.