THE LAW OF INHERITANCE; OR, THE PHILOSOPHY OF BREEDING

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"Still, through her motes and masses draw
Electric thrills and ties of law,
Which bind the strength of nature."
— EMERSON.

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THE PHILOSOPHY OF BREEDING.

It is now nearly three years since I made my first attempt to write a work on the breeding of domestic animals. I had collected a considerable mass of information, chiefly so-called facts, and it seemed an easy matter to bring these into shape for the illustration of principles which could be enunciated as laws. I soon, however, realized the difficulty of using this material to produce an harmonious result, as the grouping was not only arbitrary, but the laws which they were intended to illustrate were but empirical formulæ, whose mutual connections could not be shown. I therefore determined to seek, through further study, a solution for my difficulties; and I may here say that my realization of the importance of force as fashioning the phenomena of vitality came entirely from a series of inductions. The facts were grouped under laws which seemed to formulate the conditions under which they occurred, and these laws, in turn considered as unities, pointed unmistakably to a superior law, which in its turn influenced their occurrence,—the law of persistence of force. This brief paper is not presented in order to prove a theory, but as an outgrowth arising from the supposed recognition of a cause.

The cell was taken as the groundwork of my scheme, for microscopic study had familiarized me with these unities of vitalized structure, and belief in a reign of law had led me to

a firm conviction that the working of natural law was universal; and if completed structure was governed by any power, then the individual parts of that structure must be influenced by the same ruling. Hence the search after truth must be from the simple to the complex, rather than the reverse.

Every change of matter must be produced or caused by some previous condition, for every effect must have its cause. This which accomplishes is called a force, and the change is the measure and exponent of the force used. Force is, therefore, a conception of a real existence, which, although unseen to our eyes, and not cognizable to our senses, can be studied from its effects, for these are seen and recognized, and may be grouped; they can in turn be converted into the unseen, and again be reconverted into the seen, and, through modern science, so measured and accounted for, that it may be said with certainty, *forces are indestructible.* Forces are also strictly subject to the law of quantity. A given quantity of one force can produce a definite quantity of another. The conversion of a force may change its apparent character, and the phenomena produced by the two forms may be widely different. This is illustrated in heat and motion, electricity and magnetism, animal and vegetable life.

Like causes produce like effects when acting in a similar manner on similar material. We know that forces may be represented by forms, and that difference of form will indicate a difference in the construction of the force.

Force is the agent which produces changes. It has, as a conception, a numerical value and a direction of action. It can, therefore, be increased or diminished, and its direction may be interfered with or antagonized by other force. The concrete force is the equilibrium of all these opposing forces. Any change must be produced by an equivalent change in the force which is represented by the object undergoing change.

This work is but applying the doctrine of persistence of force to vitality, as it has already been applied to physics. The forces governing vitality, chemistry and physics, must needs be but forms of the same force. Nature seems to work always under law, and her phenomena, in successive group-

ings, continually point to governing laws, and these in turn to others, until we must conceive of one great final law, in infinity, to which all others are subordinate.

INTRODUCTORY.

In the higher classes of animals our first knowledge of the individual life is of the union of two germs,—the one furnished by the female, the other by the male. The product of this union is a determinate one, and is influenced in a varied degree by multitudinous causes, the more proximate of which are parentage and environment, and the more remote the antecedents of the individual and the race.

The creation of the individual and the fixing of a type for a domestic breed is, under law, largely within the power of man, and the understanding of the action and reaction of law on law, in the production of certain ends of animal structure and function, constitutes the science of breeding.

The science of breeding is not necessarily an exact science. It deals with concrete phenomena, and its predictions must be, in the main, general. By acting in conformity with its predictions, the probabilities of the successful attainment of our ends in the individual is very largely increased; when individual knowledge of the laws of causation is understandingly applied to the problem of breeding certain results from an animal of known antecedents, the probabilities of the position have a near approach to certainties.

The scientific breeder is one who applies the laws governing the art with an understanding of the reasons upon which his expectations are based; while the practical breeder is one who follows rules established by experiment and belief for the government of produce and production. It is as the art of breeding is united with the science that the best results may be expected; and practice is dependent on science for its correctness and the enlargement of its usefulness.

To the believer in causation—a principle which underlies the practise of all science—the animal structure and function is a result produced by, and in conformity to, law; and were the whole history of all the forces which have taken part in the production of individual animals so laid out before a

mind capable of investigating the process, and which could so estimate their various values as to project them in a mechanical form, a figure could be drawn in which the resultants of the forces could be represented by a line, which would invariably indicate the value of the concrete forces which would be the contribution of the parties to reproduction. This is to say that certainty of result would follow complete and exact knowledge, and the corollary is equally obvious, that when we have uncertainty in practice, it can be explained by the deficiency of our knowledge.

To demand this complete knowledge is to demand a mind which is infinite to our present conceptions; but it is in our power to continuously encroach upon the borders of our ignorance, and, while extending the boundaries of our knowledge, gain increased control over the forces of nature.

The study of physics, or philosophy applied to nature, to me, at least, indicates the possibility of "spontaneous * generation." But as this doctrine, so reasonable in itself, is the subject of so much prejudice, and not as yet satisfactorily demonstrated, we may at present claim that life is always derived from preëxisting life. The terms which we apply to this derivative process are reproduction and generation. The word reproduction is general in its meaning, and includes the history of the changes which take place in the organs and functions of the individual, by means of which new matter is formed, as well as the production, growth and development of the new germs which make their appearance through generation. The word generation, strictly speaking, has reference only to the changes immediately following the act of begetting, but usually includes somewhat of the past history of the separate cells which take part in this process, as well as some history of the development of the new life thus formed. The generative process appears to consist essentially in the union of the contents of two cells, or the differentiated product of one cell, by which the germ of what may

* Spontaneous: I use the word in the sense of produced without any special cause or method being assigned, as of the appearances of life without any evidence of its being produced from an existing vitality,—that is, the convertibility of forces. To use the word as if it involved the production of life without cause, or not in accordance with law, would involve an absurdity of thought.

become an independent life is the result. Development is the sequel to generation.

The reproductive process in itself consists in the formation of certain cells from preceding cells through well-defined procedure. It may be by subdivision, by gemmation, or through the intervening act of generation. When, by subdivision or by gemmation, each act of development appears to diminish the germinal capacity; when, by generation, the germinal capacity appears to be renewed. By subdivision is meant the method of multiplication of cells, which, for a time, may retain their juxtaposition; by gemmation, the formation of cells which are to be cast forth, the commencement of a separate existence. The reproductive process includes the repair of injuries and the increase and renewal of parts. Growth may be the sequel to reproduction.

Life may be said to commence with the cell, for it is only at this stage that we ordinarily recognize individuality. In the higher animal structures, as in the mammalia, we have the whole structure either built of or derived from cells, presenting a most varied and complex appearance as viewed in their completed state, but which, when studied with reference to their history and development, are seen to be all derived from this same formative element. Each cell is or has been at some time, within certain limits, an individual and independent whole, in which the vital processes are or have been repeated; as in one, so in all. Although presenting this apparent individuality, yet, in the animal structure, these separate units are all combined, each with all, to form the harmonious whole,—the animal life.

The study of the cell is the foundation from which the science of breeding is to be built up, for natural law is universal and simple and unvarying, acting on all alike, but its actions disguised by environment. That the law may be seen in its primal force, it is necessary that its workings should be sought for amid the simplest conditions and amongst the least complexity of structure.

THE CELL.

The cell proper, or the ideal cell, is a homogeneous and extremely simple structure, which may be defined as merely

substance within an enveloping membrane. Within a cell we usually expect to find a nucleus, or, possibly, within the nucleus another cell, which we call a nucleolus. These inner cells are almost invariably of a round or oval form, offer greater resistance to the action of chemical agents than do the external parts, and are those parts which are the most constantly found unchanged. The nucleus seems less connected with the function and specific office of the cell, according to Virchow, than with its maintenance and multiplication as a living part.

For the existence of the cellular element, such as we are to consider, two things are requisite,—the membrane and the nucleus. The contents change according to position and function. With these two forms,—*the membrane and the nucleus*,—we are enabled to examine critically the basis of some of the phenomena attending life.

In the embryonic state we can readily detect the time when the whole structure is composed of cells, and as we pass onward towards birth, we see these cells changing their form and function, becoming differentiated as it were, in an increasing ratio with the age. The cells multiply, change their form and their function, which necessarily involves their contents, until in the grown individual it is difficult to trace the connection between these elements in the various parts. The cells change, but while the activity of the cell remains, the nucleus can usually be detected. The muscle-cells become elongated and become filled with contractile matter, and capable of transmitting force; the nucleus remains attached somewhere to this cell and is unchanged. So with the nerve-cells; the contents differ from the muscle-cells, and it is but the nucleus which remains to indicate the kinship. We also find changes going on in the shapes of cells by outgrowths, by division, by absorption, and even by secretion and growth. These cells containing nuclei are, in fact, individual units of a living organism, and themselves containing life and undergoing vital processes, go to make up the concrete life we recognize in the formed animal.

As the processes which these vital unities pass through are all allied, we can consider some of the laws of reproduction, as derived from the study of the simple or ideal cell, leaving our