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this connection, that Jacob in his death-song speaks of ships in connection with the coast of Canaan (Gen. iv. 9), while in Exodus the mother of Moses calls her little basket of papyrus, in which her child was placed on the river an Ark. It was certainly not a ship or boat; but like Noah's Ark a box or basket coated with bitumen, and on a small scale intended for a similar purpose. I have in the publications already referred to shown that the Ark was a refuge only for selected kinds of animals, not for all the animals in the world; that is, if we take our idea of its inmates from Genesis rather than from a toy "Noah's Ark."

We may safely predict that the biblical history of the antediluvian time and of the Deluge will be more and more valued as knowledge advances, and that it will be more and more clearly seen that they could not have been written or compiled later than the Mosaic age. In the meantime one may be thankful for a record which places those primitive and otherwise prehistoric men, known to us outside of the Bible only by their bones and implements, in rational and spiritual contact with ourselves, and renders their history helpful to us and to our children in these "last days."

J. WM. DAWSON.

MATERIALS FOR THE STUDY OF VARIATION.¹

Any researches which have for their object the advancement of our knowledge concerning the origin of the living inhabitants of the world cannot fail to be of interest to the student of Biblical exegesis. As our theory of creation must, in some degree, affect our view of the relation of God to the universe, it is important to note that with the pro-

¹ *Materials for the Study of Variation, treated with especial regard to Discontinuity in the Origin of Species.* By William Bateson, M.A., Fellow of St John's College, Cambridge. (London, Macmillan, 1894.)

gress of knowledge in natural science, there have taken place certain corresponding changes in the current beliefs of the Christian Church in reference to such matters as the nature and duration of the processes whereby the existing order of nature has come into being. The old faith in an instantaneous creation of things as they are has almost become extinct; and most of the leaders of Christian opinion have become so far leavened with the spirit of the age as to adopt some form or other of the evolution theory of the origin of the universe.

The fundamental physical condition that is always associated with life is *change*. Every organic tissue, while it has life, is undergoing a constant metamorphosis both in its material and in the way in which that material is built up. Still further, every organic being, taken as a whole, participates in this changefulness, so that while in a general way it resembles its parents, yet it possesses a distinctive individuality of its own. This, which is a matter of common observation, is expressed by the familiar formula that all organic beings have a tendency to vary.

While the animal and vegetable kingdoms as known to the naturalist thus consist of myriads of individuals, each with its personal characters, these individuals can be classified along definite lines. The individuals can be grouped into species, which are categories that can be marked off from each other by distinctions more or less pronounced. These categories do not make a continuous chain, insensibly shading into each other; but they appear as a discontinuous series of specific forms, each of which exists in the conditions the most advantageous for its welfare. Any adequate evolution theory must take account of these two phenomena, the discontinuity of existing species and the adaptation of each species to its surroundings.

The older hypothesis of Lamarck was an attempt to account for these phenomena on simple mechanical principles.

The individual organism was supposed to be plastic, and to respond to the influences of its environment, thereby acquiring new characters. These new characters were hereditarily transmitted, and thus the diversity of specific forms in the organic world was explained.

But the most careful observations made under the most diverse conditions have thrown so much doubt on the hereditary transmission of individually acquired characters, as to discredit this portion of the theory. Also the plasticity of the individual organism has been shown to be subject to so many limitations, that the sufficiency of this method of accounting for the variety of existing specific forms has been practically given up by all biologists.

Darwin's theory does not profess to account for the tendency of the individual to vary from being a perfect repetition of its parent. He accepts this tendency as a fundamental postulate, and argues that some of these spontaneously arising variations will be so correlated with the environment of the individual as to give it an advantage in the struggle for life over those individuals which do not present a like advantageous variation. The forms which are so favoured become strong, and are perpetuated, while the weaker are starved out. To this process the term natural selection is properly given; it does not profess to be a cause, and it leaves on one side the consideration of the fundamental question: Why and how do these advantageous variations occur? This is forgotten by many of those who speak or write loosely on the subject: and Mr. Bateson very truly says that "the crude belief that living beings are plastic conglomerates of miscellaneous attributes, and that order of form or symmetry have been impressed upon this medley by selection alone, and that by variation any of these attributes may be subtracted, or any other attribute added in indefinite proportion, is a fancy which the study of variation does not support."

Most of the exponents of Darwin's theory have assumed that the differences between species and species are compounded of the accumulated individual differences between parent and offspring that have arisen in the long sequence which makes up the genealogical tree of the group; in other words, that variation is continuous, and that the specific difference between two forms is the summation of a gradually increasing series of small divergent variations.

The only method whereby the accuracy of this assumption can be tested is by the systematic study of existing variations; but as we have seen that every individual shows some form of variation, the complete discussion of the subject becomes a task so gigantic as to be practically out of reach. However, Mr. Bateson has attempted in this work to give a first instalment of a systematic study of the phenomena of variation; and has set himself to determine in a few departments of organic nature whether such variation as we can observe taking place before our eyes is continuous or discontinuous (that is—*per saltum*).

This volume is the record of prodigious labour, both of actual observation and also of bibliographical research. It is so full of facts that it is not easy reading, but the arrangement is good, and the illustrations are excellent. Since the publication of the *Origin of Species*, there has scarcely appeared such another monument of individual labour.

As the result of the careful and patient digestion of the enormous mass of observations here collected, Mr. Bateson comes to the conclusion that varieties arise discontinuously, and as the diversities of the environment of the individuals shade into each other, the source of the discontinuity must reside somehow in the living thing itself.

This demonstration of discontinuity in variation bears directly upon some of our current biological conceptions. Few ideas have taken a more forcible hold on the public

mind than that of heredity, which is often spoken of as if it were an independent and dominating force. Mr. Bateson points out that the sense in which this word is most commonly used is a metaphor derived from the transmission of property from father to son, and that, in consequence, it is apt to convey a fundamentally erroneous idea of the nature of the developmental process, as it suggests that the body of the parent is in some sort remodelled into that of the offspring, and that hence a whole series of errors arise. In nature, the body of the individual has never been the body of its parent, and is not formed by a plastic operation from it; indeed, as Mr. Bateson remarks, on the current theory of Weismann, the parental relation is rather that of a trustee than that of a testator. Heredity is a convenient term to express the general resemblance of offspring to parents, and the occasional re-appearance of the individual peculiarities of parents in their offspring; but we are yet far from any satisfactory hypothesis whereby to account for these phenomena; and our terminology is likely to mislead if we personify heredity as though it were an independent force.

It has been supposed by some biologists that certain discontinuous variations are reversions to an ancestral condition, but the detailed study of the forms so varying shows that they vary often in directions so different that they are mutually exclusive. Indeed, it is only in a few cases that the invocation of a supposed suitable ancestral form to explain the occurrence of such a sport is warrantable. "We suppose that a certain stock gives off a number of individuals which vary about a normal; and that after having given them off, it begins to give off individuals varying about another normal. We want to say that among these it now and then gives off one which approaches the first normal, that shooting at the new mark it now and then hits the old one. But all that we know is, that now and

then it shoots wide and hits another mark, and we assume from this that it could not have hit it if it had not aimed at it in a bygone age. To apply this to any other matter would be absurd."

Mr. Bateson very wisely does not venture into speculations as to the causation of varieties. Our knowledge as yet does not warrant any such theorising. He has earned the gratitude of all biologists by his boldness in acting as pioneer in a most arduous task; and he deserves the thanks of all thoughtful men for the spirit in which he has carried out his researches. "In these days there are many who do not fear to speak of these things with certainty, with an ease and an assurance that in far simpler problems of chemistry and physics would not be endured. For men of this stamp to solve difficulties may be easy, but to feel difficulties is hard. Though the problem is all unsolved and the old questions stand unanswered, there are those who have taken on themselves the responsibility of giving to the ignorant as a gospel, in the name of science, the rough guesses of to-day, which to-morrow should forget."

"On the first page I have set in all reverence the most solemn enunciation of that problem which our language knows" (1 Cor. xv. 39). "The priest and the poet have tried to solve it each in his turn and have failed. If the naturalist is to succeed, he must go very slowly, making good each step. He must be content to work with the simplest cases, getting from them such truths as he can, learning to value partial truth, though he cheat no one into mistaking it for absolute or universal truth; remembering the greatness of his calling, and taking heed that after him will come Time, that 'author of authors,' whose inseparable property it is ever more and more to discover the truth, who will not be deprived of his due."

ALEX. MACALISTER.