

PROTOPLASM, PAST AND PRESENT.

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THE present-day student has become so familiar with the term protoplasm that he has hardly any conception of the important part which this substance has played in the history of biological and philosophical science. It is now about forty years since the doctrine of protoplasm was formulated and thirty-five since Huxley devised the famous phrase, "Protoplasm, the physical basis of life." With the conception of protoplasm was inaugurated modern biology. At that time it was pointed out that the physical basis of all living things is always the same. Wherever there is life there is present a homogeneous jelly-like substance, chemically related to albumen. This substance, protoplasm, is indeed the only living substance, all parts of the animal or plant which are not protoplasm having been made by the protoplasm. Such a conception of course greatly simplified the study of living things, since it definitely pointed out the fundamental living substance to be studied.

But the real significance of the new era lay rather in a different direction. The fact was that the doctrine of protoplasm, as advanced by Huxley, gave to the scientist a promise of a speedy manufacture of living matter by artificial means. Protoplasm was described as a chemical compound related to albumen and composed of the same chemical elements, carbon, oxygen, hydrogen and nitrogen. It was said to be a very complex compound indeed, having many hundreds of atoms in its molecule; but nevertheless it was looked upon as a definite compound, or a simple mixture of such compounds. With this conception, life was simply a name given to the peculiar properties of the compound. Hydrogen is a gas with certain properties, and oxygen a second gas with properties of its own. If these two gases are brought

together they will unite by chemical affinity and form water (H_2O). Now, water is very different from oxygen or hydrogen. It has definite properties of its own, but no one ever thought of saying that it is endowed with a special force, "aquosity." Albumen is another compound with still more complex properties, but no one thinks of saying that these properties are due to a special force of "albumity." They are doubtless properties of the compound and explained by the properties of the chemical elements which make up the albumen. So, it was said, when these same elements unite to form the still more complex compound, protoplasm, with even more complex properties, there is no reason for saying it is due to any force of vitality. Vitality, in other words, it is said, is only a name given to the properties of a certain definite chemical compound.

But the significance of protoplasm was even deeper than this, for it appeared that it should be possible for chemists to manufacture this substance. Chemists have at their disposal the force of chemical affinity, and by using this force they can cause the simple elements, carbon, hydrogen, oxygen and nitrogen, to unite to form simple compounds such as CO_2 , H_2O , NH_3 , etc. By combining these compounds again they can make more complex ones, and the more they experiment the more complex become the compounds which they succeed in making. By purely chemical means they find themselves beginning to climb a ladder of chemical compounds. At the bottom of the ladder are the simple chemical elements. The various rounds of the ladder are the organic compounds of increasing perplexity, such as alcohol, starch, sugar, etc. The upper rounds are such substances as albumen. Now, the doctrine of protoplasm told the chemists that at the top of this ladder stood proto-

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