fact: it is determined by natural conditions, and not by the voluntary decision of individuals.

J. J.

A SUGGESTION FROM MODERN EMBRYOLOGY.

ONE of the obstacles which proved to be a difficulty of considerable weight to Darwin in his application of the descent theory was the sudden appearance of a highly developed fauna in the Silurian age. This difficulty has not decreased, but has rather increased with the further knowledge of that fauna. The primordial fauna, as shown by the fossils of the Silurian rocks, was not what naturalists would have assumed had they been called upon to construct this fauna from *a priori* grounds. Instead of a few simple generalized forms, these early rocks showed evidence of a highly diversified fauna. In the Silurian rocks are represented all of the great divisions of the animal kingdom, including even the vertebrates. Moreover, of the smaller divisions, a sufficient number are here represented to cause considerable surprise. About five-sixths of the orders now existing, nearly an equal proportion of sub-orders, a great many families and some genera of to-day are found in these earliest rocks. It is indeed remarkable to find such a very large number of existing groups represented in the earliest fauna of which we have any knowledge. It is true that the Silurian age lasted a long time, and that in the lower Silurian the fauna is not quite so diverse as above indicated; but even here it is sufficiently diverse to be surprising. When the history of vertebrates since that time is compared with the history of other groups, the contrast is very striking. They have had time enough to develop from the very lowest forms — which we judge lived in the Silurian times — into the present highly diversified groups. But with all other groups of animals the advance has been comparatively small. It must be assumed, to reconcile these facts with evolution, that enough time elapsed between the beginning of life on the world and the beginning of the Silurian to develop all of the sub-kingdoms except the vertebrates to a high degree of differentiation. And, when the great amount of time which it has required to develop the vertebrates is taken into consideration, the amount of lost time necessary to assume previous to the Silurian seems too great to be credible.

It will, of course, never be possible to reconcile the Silurian fauna with evolution without the assumption of a long lost period of this character. But certain general results from modern embryology are in this connection suggestive, and indicate that the difficulty is not so great as has been sometimes conceived. For modern embryology is teaching us that our various sub-kingdoms are all direct modifications of the most primitive multicellular animal. Using embryology as a guide in interpreting animal history, naturalists have been continually shortening this history, particularly at the bottom. From the time when Haeckel traced the genealogy of man through twenty-one stages, these stages have one by one been dropped by naturalists, with the result of making the history a much more direct one. Finally, the recent theories of Sedgwick, and others who follow him wholly or partially, would make the history of all animals much shorter by showing that all the sub-kingdoms may be regarded as resulting directly from modifications of the gastrula by slight changes in its shape. We once derived the worms from the coelenterates, the annelids from the lower worms, and the vertebrates from the annelids; but now all of these groups are derived directly from the gastrula itself. This theory of Sedgwick is receiving support in some form from many sources — at least, so far as concerns this feature of it. There is certainly a tendency to-day to look upon a greater and greater number of types as direct modifications of the original animal represented by the gastrula stage. Coelenterates, polyzoa, brachiopods, mollusks, annelids, and vertebrates have all been shown to be derivable from the gastrula by simple direct modifications.

Now, we must remember that slight variations at the bottom of a diverging series produce much greater effects than variations higher up. When a tree is first sprouting, differences in the direction of its buds determine the shape of the future tree; for these early buds become the great branches, and the slightest difference in their direction is enough to cause a wide separation between them as growth goes on. After the tree has grown to a considerable size, its buds no longer produce great branches, but only small ones, or perhaps only twigs. Growth cannot now change the general shape of the tree, but only increase the profusion of small branches, twigs, and leaves. That such a relation represents the history of the various groups of the animal kingdom is unquestionably the teaching of modern embryology.

The significance of this result in enabling us to understand the fauna of the Silurian rocks is evident enough. It not only shortens the time necessary to be assumed prior to the Silurian, but it also enables us, partially at least, to understand the presence at this early period of such a large number of our present existing types. For the protozoan to develop into the first multicellular animal, represented by the gastrula, must have

taken a length of time of which we have no means of getting an idea. But after this animal was developed, the origins of the various great types were not serial, but simultaneous. This animal began to be modified in various directions to fit its surroundings, and the result was a rapid divergence of groups. Slight variations in these simple types would cause the descendants of the various lines to separate still further. We can therefore imagine the Silurian times to be somewhat close to the origin of life, and yet not be surprised at the existence of all the greater divisions of the animal kingdom, and many of the smaller ones. We can also understand why it is that the development of most groups since that time has resulted chiefly in the increase of the abundance and diversity of small branches. For the Gastrea, having diverged into several great branches, has itself disappeared as such, and can of course produce no new sub-kingdoms. Development must now take place within the branches, and must confine itself to smaller and smaller particulars as evolution progresses. Modern embryology, therefore, showing as it does the early divergence of the great types, offers to us an explanation both for the highly diversified fauna of the Silurian age, and for the comparatively less importance of the development that has taken place since that time, even though post-Silurian times be recognized as very much longer than pre-Silurian times. And we are finally led to believe that the vertebrates also were much more abundantly represented in this fauna than the scanty remains hitherto discovered would indicate.

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POLITICAL SCIENCE IN FRANCE.

AS M. Donnat well remarks, politics in France have been largely based on sentiment and abstract reasoning rather than on the lessons derived from observation. Frenchmen are confessedly adepts in constitution-building, but so little acquainted are they with the practical history of political methods that they have not yet arrived at the stage of regarding politics as an art, much less as a science. It is well, therefore, to notice these two works[1] as written in the spirit of comparative politics. M. Donnat maintains that there is a science of politics whose principles are as unvarying and determinate as the laws of the natural and physical sciences. A political solution may be compared to the product of the two gases in fixed volumes to form the molecule of water; nor is there any higher power to introduce uncertainty in the operations of political forces. This is no new thought; and if the English reader wishes to understand the significance of such political inquiry, free, however, from the particular irreligious character of M. Donnat's thinking, he is already in possession of the suggestive work by Sheldon Amos on 'The science of politics.' While the latter has the advantage in philosophic treatment of the subject, the former is more imperative in his claims for the purely scientific nature of politics. He is constantly suggesting parallel illustrations from the other sciences, and derives much comfort from a contemplation of the methods employed by Claude Bernard in his development of the science of medicine. M. Donnat's spirit of inquiry, nevertheless, is admirable, and one sure to be fruitful in its results. He is animated by the spirit which prompted De Tocqueville, Comte, and Le Ploy. Like the first, he has travelled much abroad; and his knowledge of English and American political life extends even to the details of such legislation as our homestead laws. In early life he hoped to find in Comte a guide, but this master soon turned aside, and became a divinity. In Le Ploy, also, he well-nigh found a kindred spirit; but, instead of persisting in those remarkable studies of the civic and industrial institutions of European society, this profound thinker also was drawn into immature synthesis, in declaring that religion was indispensable for private and public life. With M. Donnat it is ever observation and experimentation in politics. The former, on account of the complexity of political phenomena and political Daltonism on the part of the observer, is insufficient. It must be supplemented with experiment. The great success of the Swiss, English, and Americans has been due to their adoption of this principle. Their legislation is not only of local application, but limited in time; and the different legislative assemblies of England's colonies are compared to so many political laboratories. In France, however, legislation is indiscriminating. The colonies have no local voice. An enactment of the Palais-Bourbon is as far-reaching in its provisions as the limits of the most distant colonial possessions. Nor is legislation of that tentative character which should be the spirit of all genuine scientific inquiry. The author, therefore, earnestly pleads that France cut loose from its hard and fast methods, and make trial of local and temporary legislation.

M. Guyot is even savage in his criticisms. The arraignment of French colonial policy is exhaustive in its details. The budgets and commercial statistics of colony after colony are taken up and

[1] *La politique experimentale.* Par LEON DONNAT. Paris, *Reinwald*, 1885.

Lettres sur la politique coloniale. By YVES GUYOT. Paris, *Reinwald*, 1885.