Great Bathylithic Invasion were one after the other definitely distinguished.

The itinerary of the geologic party and series of discoveries are briefly stated by Professor Berkey as follows:

Left Kalgan April 21. Went into camp at Iren Dabasu after finding rhinoceros jaw evening of April 24. First dinosaur bones found at Iren Dabasu morning of April 25 by Berkey before breakfast. Camp was divided April 25, leaving the geologic group, Morris, Granger and Berkey, at Iren Dabasu, giving special attention to the collecting of fossils. First finds of Titanotheres and other early Tertiary fossils by Granger at Irdin Manha April 27. Additional finds made at Irdin Manha by the geologic group May 2. First Baluchitherium bones found at Houldjin in the vicinity of Iren Dabasu, April 30, by Berkey. Geologic group stayed at Iren Dabasu until May 7. Basin later referred to as Tsagan Nor Basin was entered first at Mt. Uskuk June 21 by the whole party. First exploratory trip to Loh June 22 by the group, with recovery of a few fragments of bones. Discovery of dinosaur bones and fossil insects and fossil fish June 25 in the Ondai Sair locality by Berkey and Morris. Three great collections of Later Tertiary fossils judged to be of Miocene age made by Granger at Loh in the Hsanda Gol formation June 27-August 3. Discovery of Baluchitherium skull at Loh August 4 or 5 by Granger and Wong. Discovery of stag, mastodon, etc., judged to be of Pliocene age in the Hung Kureh district July 27 by Berkey. Whole group made collections later. Left the Tsagan Nor Basin August 13. Discovery of dinosaurs in the Ashile District by Granger August 20-27. Side trip to the Gurban Saikhan across a new basin by Morris and Berkey August 19-27. Discovery of Protoceratops by Shackelford at Dja-doch-ta September 2. Additional collections by the whole party. Discovery of Paleozoic strata with Permian fossils September 7 in the Sair Usu district by Berkey and Morris. Discovery of Ardyn Obo fossil-bearing beds September 10. Collections by the whole party. Discovery of Eocene forms in the sedimentary beds of Shara Murun by Granger and Andrews September 14. Discovery of fragments of bone in the sediments at the edge of the Mongolian plateau above Kalgan by Berkey September 19.

The first fossils brought back by Mr. Shackelford, photographer of the expedition, included the three great discoveries of the season, namely, (1) a superb *Baluchitherium* skull found east of the Altai Mountains, which is now being fully described by the writer; (2) a complete skull of *Protoceratops*, a pre-dentate dinosaur, ancestral to the giant Ceratopsia, just described by William K. Gregory; (3) jaw of *Protitanotherium*, which will shortly be described by the writer in *American Museum Novitates*. The main shipment of the Mongolian collection has just reached the American Museum and includes all the fossils collected on this very rapid reconnaissance. During the present season the same beds are being visited by a strong collecting party and already reports of additional discoveries of importance are reaching the museum.

HENRY FAIRFIELD OSBORN

SOME EXPERIMENTAL STUDIES ON THE CENTRAL NERVOUS SYSTEM[1]

ONE of the great contributions of the last century to the field of biological science was the application of experimental methods to the study of development, and the factors underlying the production of individual structure. Though many of the fundamental facts of embryology were known, the complexity of the factors which operate during the process of development was so great that further progress could be accomplished only by segregating or isolating certain structural units and by changing intrinsic and extrinsic relations to so modify the conditions of development that some tentative answers could be made to the question of causation in development.

One of the interesting problems in nervous embryology has been: What makes neuroblasts differentiate into neurones? and as a corollary to that, Why do neurones, whose cell bodies lie in a certain region, grow over a definite pathway and establish connections with another group of neurones so that they may become part of a complex chain of nervous units?

By experimental methods, Dr. Harrison has shown clearly that neuroblasts will develop into neurones when isolated from many of the normal environmental factors. Primitive nervous tissue from the central nervous system of the

[1] A paper read before the Tri-State Medical Society in New Haven, April 19, 1923.

chick will grow in tissue cultures into apparently normal neurones. So long as the growing nerve cell is supplied with the necessary food, a certain amount of growth and differentiation will follow, without the presence of many of the normal conditions of development such as position with respect to other cell masses, hormones, chemical constituents of blood, of functional activity, etc. Just how complete this growth is, just how perfect a neurone is developed under such experimental conditions is of course questionable. But at least one fact was thereby established, namely that nervous tissue inherits a certain potential for differentiation which will result in a considerable degree of development of a cell even though isolated from its normal environment.

Stimulated by Dr. Harrison, though using somewhat different methods and working with another form of animal, I have been engaged for the past few years in studying some of these problems. The larvæ of a small native salamander, Amblystoma, are peculiarly suitable for experimental work of this sort. They grow in quantity in the pools around New Haven, can be readily kept in the laboratory and can be operated upon before the development of the peripheral nerves, without asepsis. It is possible under laboratory conditions to remove or transplant portions of organ systems, to isolate organs such as the eye or nose, to interpose organs, an eye for an ear for example, to move organs from their normal position to some strange location, an ear on to the flank and so on. All these operations are performed before the development of the peripheral nerves and hence removes the disturbing factors of shock and pathological sequelæ.

The results of several years of such experimentation have shown a number of interesting things. If the primordium of the nasal apparatus be removed at an early stage, that part of the brain to which the olfactory nerve runs for a time develops normally, then as functional activity begins, it lags behind the hemisphere with undisturbed relations. This confirmed by experimental methods a theory of Roux that in the development of the nervous system two periods could be observed, the first one of growth and differentiation in which the primitive cells was transformed into a specialized neurone and the second one of pure growth during which the size of the neurone increased markedly, and its connections were more completely established. As a result, we find that the absence of an olfactory sac, and hence the olfactory nerve results in the retardation of the normal growth of the cerebral hemisphere, or in other words, when the olfactory nerve and sac are present, the hemisphere will grow to a greater size than when it is lacking. These results suggested the possibility of function as the stimulating factor in the second, or growth period, of nervous development.

In order to determine exactly whether or not this was so, a second series of operations were performed in which the entire cerebral hemisphere with the nasal apparatus attached, was transplanted back onto the trunk of Amblystoma larvæ. In a portion of these transplantations, the transplant was so placed that the olfactory placode healed in beneath the skin so that there was little possibility of its functioning. In the rest, the complex was placed with the olfactory sac at the surface so that it might conceivably function. The results of these operations showed that the stimulating factor for the second growth period was probably not functional activity but rather the stimulus afforded by the ingrowing olfactory nerve, since in both series the size of the hemisphere closely approximated the normal undisturbed hemisphere.

Questions that immediately arise are: How potent a factor is this stimulation which results from a nerve trunk or tract growing into a collection of nerve cells? Would it be great enough to bring about regeneration of such a mass and would the presence of a nerve trunk larger than normal produce an enlargement of such a mass of nerve cells?

To answer the first question a series of embryos were operated upon in which the cerebral hemisphere was removed, and the olfactory sac returned to its normal position. In the process of healing the inter-ventricular foramen left open by the removal of the hemisphere was closed in by a thin layer of cells derived from the ependymal lining of the neural tube. When the ingrowing olfactory nerve reached this new portion of the wall of the neural tube, the latter were stimulated to differentiate and develop into a complete new hemisphere, which in both structure and size was apparently a completely normal hemisphere. We can, therefore, answer the first question in the affirmative. A group of axones growing into a collection of primitive cells is able to cause them to regenerate a complete new part of the brain.

To determine the stimulating effect of a larger nerve trunk than usual on neuroblasts, an extra olfactory sac was transplanted beside the normal one in such a way that the ingrowing nerve trunk could establish connection with the hemisphere. Here, though, in some instances the olfactory nerve did not reach the cerebral hemisphere. In those cases in which it did, the hemisphere increased in size markedly over the normal hemisphere. The results obtained showed that the growth into the cerebral hemisphere of more axones from olfactory neurones than normal produces an enlargement of an embryonic nervous cell mass, since the hemispheres in such operated embryos eventually grew to be approximately 20 per cent. greater than normal.

The experiments show, then, that the removal of an end organ results in the failure to grow to full size of the part of the brain with which it is connected, that ingrowing fibers from such an end organ can stimulate the primitive ependymal lining of the neural tube to form a new portion of the brain and that a superabundance of such ingrowing nerve fibers can stimulate the normal brain to increase in size approximately 20 per cent.

To put it in another way, the above experiments show that nerve cells grow, first as a result of an inherited potential for differentiation, and secondly as a result of stimulus derived from the contact of telodendria from other neurones. This latter stimulus is, in Amblystoma, sufficiently strong to produce regeneration and hyperplasia of the cerebral hemispheres. Functional activity is not excluded as a factor since we do not yet know what occurs when neurones establish connections within the central nervous system. The exteroceptive phase of functional activity at least has little or no effect.

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THE MASKELL COLLECTION OF COCCIDÆ

WILLIAM MILES MASKELL was registrar of the University of New Zealand. He pursued the study of the Coccidæ when not busy with the arduous duties of his official position. His first paper was published in 1879. With the exception of four years, he published an annual illustrated memoir, 1879-1898, in the *Transactions* of the New Zealand Institute. In addition to the memoirs about twenty other papers were published. These included a very large number, several hundred, new genera and species. He had the advantage of being located in the midst of a marvelously rich coccid fauna.

Many of the species of Coccidæ have proved to be of economic importance. This has resulted in the discovery of many new forms. The description and study of these new forms has brought to light many characters either not figured or not described or noted by Maskell, so that his genera and species needed to be restudied in order to determine their correct affinities and to permit of their proper location in the classification of the family. The officials of the U. S. Bureau of Entomology were able through the assistance of Mr. T. W. Kirk of the New Zealand Department of Agriculture to borrow this collection, which reached Washington in 1909.

The remounting and study of the collection was begun immediately. The first results of these studies, thirteen years after the reception of the collection, have appeared and deal with the species of Maskell that have been made the types of genera by Maskell and others. This contribution is by Harold Morrison and Emily Morrison, printed in the *Proceedings* of the U. S. National Museum for 1922.

There is included a discussion of the species belonging to seven subfamilies, and thirty-seven genera and subgenera. The authors have attempted to describe each species so fully and to figure all parts so carefully that future workers would have no need to consult the original type-material. How successfully this has been done only time will show, for with the advancement of the classification of a group, each generation frequently uncovers characters not hitherto used, so that it is very difficult for the workers of one generation to unearth all the characters that will be used by succeeding gen-