SCIENCE

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THE EVOLUTION OF CONSCIOUSNESS AND OF THE CORTEX.

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It would be difficult to find an illustration of the mutual interdependence of the biological sciences more striking than that afforded by the recent contributions from morphology, embryology, physiology, and pathology to our knowledge of the significance of the cerebrum.

It has been customary to scout at any substantial contribution to psychology from the experimental sciences, and even now, when so much attention is given to psycho-physics or physiological psychology, far too little use is made of the data of modern embryology and histology. It should be apparent to all who are not *a priori* convinced that no relation exists between consciousness and the nervous system, that no satisfactory super-structure can be reared upon any other foundation than that afforded by a minute study of the structure and function of the brain.

It is the great triumph of modern embryological histology, with Professor His as its leader, to have discovered the essential similarity of all nervous elements. What Schwann did for biology at large by means of the cell theory, Professor His has done for neurology through his theory of the neuroblast and its supplement, the "neuron theory."

It was inevitable that we should soon recognize the essential similarity in origin and structure of all nervous cells. The present writer has insisted for some years that the entire fabric of the nervous system, with the exception of a few connective and nutritive elements of secondary nature, is woven by the interblending of neurons of similar character. All such neurons are formed from the epiblast or its derivatives (the perplexing relations of the sympathic system aside). Each neuron arises from neuroblasts or formative cells springing from the ectal surface (ventricular surface by invagination in the case of the axial nervous system), and, after migration to its definitive site, takes on its distinctive character. It has been attempted to show that these are all transitions between the neuroblast and the wonderful variety of nervous elements. The nerves, whether springing from a special ganglion or from the neuraxis itself, are formed, in our view, from the moniliform union of neuroblasts, whose nuclei, when they have served their purpose in forming the fibre, become separated to form the nuclei of the sheath. The recent researches in nerve degeneration and histogenesis all favor this view.

Besides those elements which at once become transformed into the definitive nerve cells, we believe there are intermediate conditions or "reserves," which may subsequently be called into function. Upon this view there is a continuous intercallation of nervous elements going on — a process much more rapid during youth. From the same standpoint it seems probable that there are numerous proliferating stations, where such neurons are continually forming. In the cerebellum and medulla, and even in the cerebrum itself, there are such loci of rapid development. No exception has so far been encountered to the law that the neurons of the central system all spring directly or indirectly from the ventricular surface.

An attentive comparative study of the various groups of vertebrates shows that the development of the various parts of the brain obeys simple and readily discoverable laws, which, when recognized, are as self-evident as the gastræa formation of the embryo. The modifications of the brain-tube, from its primitive uniformity to the wonderful complexity to which it attains in man, form a consecutive series without any complexing hiatus.

Interest attaches particularly to the cerebrum, by reason of its preëminent position, as the latest structural modification, and its close relation to the phenomena of consciousness. Since Rückhard showed that in the fish the roof or cortex of the cerebrum is wanting, or rather represented by a non-nervous membranous pallium, considerable modifications in our conceptions of the sphere of consciousness have been rendered necessary. Remarkable experiments show that the whole cerebrum may be removed without making any noticeable difference in the habits and activities of the fish (save in the case of those functions associated with smell). The writer has studied the axial lobe of the cerebrum of fishes and described numerous distinct cell-clusters and tracts which had hitherto been overlooked. He suggested that the undifferentiated prototypes of the cell-masses, which in higher vertebrates occupy the cortex, are, in this case, retained in the axial lobes. It was shown that the centres for the sense of smell are highly and specially developed, and are connected by strong and distinct tracts with the olfactory organs. It was even ventured to locate a homologue of the hippocampus upon the basis of the tracts. This procedure was evidently regarded by some as rash, but has been amply justified by subsequent developments.

In reptiles we located the olfactory centre or hippocampal lobe in a large part of the cortex, which is closely associated with a curiously modified part of the axial lobe. We suggested that the cortical elements arise as proliferations from the axial lobe, which push out into the thin cortical walls or pallium. In the *Leuckart Festschrift* it was shown that the preplexus in amphibia is analogous in early position and structure to the pallium of fishes.

In a recent number of the *Anatomischer Anzeiger* Dr. Edinger, who is perhaps the ablest living comparative neurologist, works out this form of the solution of this problem in detail with respect to the olfactory and hippocampus. Accepting the suggestion of proliferation from the axial lobe, he shows that the earliest cortex to be formed is that which, in higher vertebrates, is termed ammonshorn or hippocampus. In other words, consciousness first intervenes in the construction of data from the olfactory sense. This suggestion is enforced by the data of comparative morphology. The olfactory is the most primitive of the special sense-organs, and is most closely associated with the cerebrum.

Several years ago we proposed the theory that consciousness must have appeared very late in the evolution of psychical functions; the higher expressions of this faculty, such as reflection, being among the latest endowments of the race. It was shown that such a view would give us less concern in the bloodthirsty procession of ferocious animals which have reddened every page of geologic history. When the greatest diameter of the nerve-tube was in the pelvic region, it was unnecessary to predicate consciousness as a pre-requisite to the simple avocations of the animal.

We believe that, under the law of natural selection, consciousness could only appear when the arena was opened for its serviceable exercise.

Remarkable confirmation of the comparatively accessory status of consciousness has been obtained from two such different sources as the study of hypnotism and experimental psychology. In a most interesting paper printed in the June number of the *Journal of Comparative Neurology* Dr. Edinger describes the results of an examination of the brain of a dog, from which Professor Goltz had removed the *entire cerebrum on both sides*.

The dog lived eighteen months, but, contrary to the predictions of the sceptical, the cerebrum proved to be all but entirely removed. The special senses were not destroyed except smell. Locomotion was not impaired, and general sensation was intact.

Although the animal was completely imbecile, it retained the nervous mechanism for nearly all bodily functions. While these results seem, at first, contradictory to those derived from extirpation and electrical stimulation, yet, as Edinger shows, they merely indicate that the organs and processes of consciousness are merely superposed upon the substructure of the instinctive processes and axial centres.

In man, who has acquired greater dependence upon reflection and other higher functions, the primitive independence of the lower centres is retained for a relatively short time during childhood. The above illustration may at least serve to show how mutually dependent all these sciences are and that we seem to be gradually approximating toward a connected theory of nervous action and evolution.

SOME CURRENT NOTES UPON METEORITES.

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It may well be hoped that the revived attention which has recently been shown in the study of that interesting class of bodies known as meteorites, will result in giving us a more practical, if not a more certain, basis for their consideration. If in the onset we meet with conflicting theories and much uncertain data, we are only upon the same ground where most scientific inquiry begins. If we cannot tell whence an aerolite comes, we usually do know the fact and date of its fall, its chemical and lithological composition, specific weight and peculiarities of structure, the phenomenon attending its flight, and often the precise radiant point from whence it came. We hold the object in our hands, and can study its physical properties, and its cosmic as well as its telluric history. All these particulars have been observed, compared, studied, and in part determined by thoroughly competent scientific men, and yet, to-day, there is no accepted scientific name to indicate their special line of research, none for this department of science itself. These primary needs are yet to be filled. Heretofore two distinguished writers and students in this field of inquiry have each proposed a specific name for the science, and, while neither of the terms seems to be objectionable, neither of them seems to have been generally adopted or used. In 1847 Shepard proposed the term "Astropetrology," and in 1863 Story-Maskelym suggested that of "Aerolitics" to distinguish it as a department of science. Both from the priority of suggestion, and as a fitting tribute to the zeal and valuable labors of Professor Shepard in that behalf, will it not be proper and convenient to adopt his proposed name, astropetrology, which, in accordance with common usage, by a simple change of its final syllable "gy" into "gist," will also designate a person devoted to its study? How comes it that a subject presenting most interesting and possibly serviceable problems in astronomy and physics should thus far be deficient in the very rudiments of a distinctive science — even a name? Certainly not from lack of patient labor and intelligent investigation by thoroughly competent men. Smith and Genth upon its chemical side, and Newton, Eastman, Langley, Kirkwood, and others upon its astronomical, have, in our country, done much to determine the data upon which present theories rest; while abroad, among a host of others, Haidenger, Meunier, Tschermak, and Brazina have worked at the very bases of efficient progress in scientific research, investigation, and the classification of the objects themselves. In this last-mentioned feature, however, lies a discouraging fact. These several systems do not agree, or rather, while serviceable and consistent in themselves, they, to some extent, seem to antagonize each other in the hands of the collector or possessor of meteoric examples. In a given example not properly labelled, or when labels have been confused, and perhaps changed places, its possessor will probably find it quite accurately described upon reference to one of these systems, but from caution, upon reference to another system, he will find described peculiarities not seen in, and possibly antagonistic to, the same fall as that which he has in hand. How is he to identify it? Specific weight may help the determination, but, standing alone, it cannot be conclusive. Chemical analysis is impracticable and not wholly conclusive. Now, if the absolute necessity of accuracy in the identification of the fall is considered for a moment, there will also result a partial appreciation of its vast importance in all its collateral as well as direct relations. For instance, the supposed example almost exactly resembles another described fall, but one occurred in India, A.D. 1822, while the other fell in Iowa in 1847, both were well observed as to radiant point, time, and course of flight, but each was the reverse of the other in all these important particulars; in short, they only resemble each other in physical characters, and a confusion of their identity may destroy all their value as data in their theoretical and astronomical relations. Identity of radiant point, time, and course of flight and a possible periodicity in observed falls will interest the astronomer even more than identity of chemical composition or physical characters, though each is a factor in his theory, and each must be, if possible, an observed fact. If a single fact may uphold or upset a theory, it should certainly be an observed fact. The purpose of these observations is to inquire what may be done to base investigations of these wonderful phenomena, the most suggestive and impressive of nature's visible displays, and the objects which they bring to us from the regions of space, upon ground more worthy of consideration and research, than as merely objects of a collecting fad, or a money-making zeal in collecting and selling examples. May we not begin by some practical methods for determining and perpetuating the identity of each example by describing and authenticating with the greatest exactness every fall and every fragment? For accomplishing this purpose the number of examples is already large, but it will be constantly augmented by new accessions which may present new physical features and new, perhaps more definite, data, the value of which will be carefully determined by the astronomer and chemist, and probably with greater fidelity and accuracy than by the observer who witnessed its fall, or the author who has the example in his hand from which to write its description. In a subsequent paper I shall venture to suggest some simple expedients for avoiding some defects and errors which have become a great and increasing obstacle to progress in this most interesting department of science.

BIOLOGY IN OUR COLLEGES: A PLEA FOR A BROADER AND MORE LIBERAL BIOLOGY.

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When it became fashionable to study physiology, histology, and embryology, the study of systematic natural history was not only neglected, but disappeared from the college curriculum, and the race of naturalists became nearly extinct. Natural history, as formerly understood, comprised geology, zoölogy, and botany, and persons versed in these sciences were known as naturalists. Geology gradually came to occupy an independent field, and is now everywhere taught separately; hence, for present purposes, it may be dismissed, with the reminder that the naturalist who knows nothing of geology is poorly equipped for his work. A knowledge of the two remaining branches — the biological branches — was looked upon as sufficient to constitute a naturalist. But the kind of knowledge taught underwent a change; the term "naturalist" fell into disuse to be replaced by "biologist," and some would have us believe that even the meaning of the word biology is no longer what it was. Systematic zoölogy has gone, or, if still tolerated in a few colleges, is restricted to a very subordinate position. Systematic botany is more fortunate, still holding an honored place in many universities, though evidently on the wane.

Is it not time to stop and inquire into the nature of the differences between the naturalist and the modern school of instructors who call themselves "biologists;" into the causes that have brought about so radical a change, and into the relative merits, as branches of university training, of systematic biology compared with the things now commonly taught as biology?

Is it not as desirable to know something of the life-zones and areas of our own country with their principal animals and plants and controlling climatic conditions, as to be trained in the minute structure of the cellular tissue of a frog? And is not a knowledge