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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

THE EVOLUTION OF THE CEREBELLUM.

THE cerebellum has unquestionably given more trouble to anatomists than almost any other organ, and our present knowledge of its structure seems disproportionate to the labor expended. It is no discredit to the monumental works of Stilling, Meynert, Purkinje, Gerlach, and Kölliker to admit that scarcely a single tract connecting the cerebellum with other portions of the brain is traced with sufficient detail. Even the external configuration of the cerebellum in lower animals has many lessons for us which may be useful in the interpretation of the human organ.

The cerebellum is subject to a greater range of variation than any other organ of the brain. From being practically absent, as in amphibia, to preponderating over all other segments of the brain in some fishes, there is every gradation in development. It becomes obvious from a brief study of the relative development of the regions of the encephalon that the cerebellum does not vary in proportion to the intelligence; that, in other words, it cannot be employed as a criterion of the position of the animal in the scheme of classification as can the cerebrum. Although not available for taxonomic purposes, these variations are none the less interesting from the clew which they may afford to the functions and laws of development of this and associated organs.

In the March number of the *Journal of Comparative Neurology* the writer called attention to the architectural modifications of the cerebellum in reptiles, and the progressive evolution of the organ in the several groups, as well as the resemblance of this course of evolution to a peculiar and apparently undescribed law of development of the cerebellum in mammals.

The cerebellum is peculiarly mobile, considered architecturally, by reason of its mode of attachment to the axis of the brain. It is morphologically the roof of the fourth ventricle. Both before and behind it is connected with the dorsal surface of the brain-tube by a velum, or thinned lamina, devoid of nervous matter, and extensively folded and combined with vascular sinuses to form a nutritive organ, the plexus choroideus (metaplexus and mesaplexus). The velum posterior extends about the sides of the cerebellum also, so that rigidity is given to that organ only by the several fibre-bundles or peduncles of the cerebellum which connect it laterally with other regions. Thus, however large and heavy it may be, the cerebellum is supported solely by a lateral axis entering at the base. There is really nothing to prevent the most extensive rotations or foldings of the body in all directions except laterally.

The progressive development of this region is nowhere more conveniently illustrated than in the reptiles. Taking the transverse bar which constitutes the cerebellar rudiment in amphibians as a point of departure, we first encounter a leaf-like body with the ventricular half of the substance composed of granular material. The tracts are chiefly scattered in the dorsal white layer. In the serpents this flap is flexed so as to form a hood-like body. The flexture is due to the so-called pons-flexture of the whole medulla. The flexture is more pronounced in turtles, and results in a complete roof over the fourth ventricle, which may be considerably arched. It is obvious that there must be a limit to the development along this line. In higher reptiles, whose motions are more active and require more accurate co-ordination, the increase in size necessary to supply sufficient nervous matter renders necessary a complete eversion of the leaf-like organ. In the lizards the lamina is folded forward in such a way as to make a double roof over the ventricle, bringing the granular layer, with its neuro-epithelium dorsad, in the superior layer, while it faces ventrad (toward the ventricle) in the ventral lamina. In the alligators the development is more extensive, and results in a horizontally placed hollow cone, with the apex directed caudad, and attached by the ventral portion of its base to the brain base. The outside of the cone is clothed with epithelium, while the inside is the morphologically ectal surface. Of course, in this description the thin velum which originally connected the edges of the leaf has been disregarded. This eversion of the cerebellum is of the highest importance in preparing us to understand the origin of the cellular elements in the human cerebrum. Before alluding to this subject we may pass in review a few illustrations of cerebellar architectonic from other classes of vertebrates.

In fishes the range of variation is remarkable, in so far that it may render the brains of closely allied genera very dissimilar in appearance. The characteristics of the fish cerebellum, which serves to distinctly separate it from all other classes of mammals, is the development of a second portion of the organ in front of the valve of Vieussens, which is the morphological anterior (cephalad) margin of the cerebellum in other cases. The relatively large amount of cerebellar substance required by active fishes, and the lack of definite walls to the ecephalic cavity, result in curious folds on a large scale and simple plan. The forward fold in front of the valve, which the writer has termed volvula, from its purse-like form, often completely fills the cavity of optic lobes, and in some cases (as the black-horse, *Cycleptus*), actually pries the two halves of the roof or tectum of that organ apart, and protrudes upon the dorsal surface with only the membranous velum tecti above it. The moon-eye, *Hyodon*, is the most reptilian of the osseous fishes so far examined, and in this case the cerebellum proper is a simple sac extending caudad: there is no external evidence of a volvula or of lateral lobes or "bursa." Sections show,

nevertheless, that there is a small volvula which lies, as in *Lepidosteus*, in the posterior part of the optic ventricle.

One curious result of the development of a volvula is the peculiar course by which the fourth cranial nerve reaches its centre. Entering at the usual place in the valve, it has to traverse a large part of the volvula before making its exit from the brain.

In the drum (*Haplodonotus*) the brain as a whole is exceedingly short. This shortening has the effect to tilt the optic lobes and cerebellum at a considerable angle with the axis of the brain, and to roll the volvula into a spherical mass with three folds, which are packed closely into the cavity of the ventricle. The main lobe of the cerebellum also has a short cephalad spur.

In the cat-fish family the cerebellum, instead of projecting backward, is thrust cephalad, affording a very good and constant differential character. The few illustrations here cited are derived from a memoir about to appear in the *Journal of Comparative Neurology*, where a wider range of comparison and full illustration may be possible.

It will be noticed that in the above cases the gray or granular material is ental. It has been shown by Professor His that the nervous elements in the spinal cord and medulla arise from the ventricular epithelium. This the writer has show is also the case in the cerebellum, at least in reptiles and fishes. In the massive cerebellum of mammals we are struck by the difficulty which stands in the way of the carrying out of the same fundamental plan of structure. The active cells are separated from the epithelium by impervious masses of fibres. How, then, do these cells reach their destination? This important question we at first sought to solve by discovering in some embryonic stage an eversion similar to that described in reptiles. This proved to be a valuable clew, but not actually correct, though a tendency to revolve from behind forward is very pronounced in the cerebellum of birds, and is exhibited in the direction of the lobules of the cerebellum in marsupials. But, while there is not an actual eversion of the cerebellum in mammals, there is a time when a pouch from the lateral posterior walls of the fourth ventricle is formed. This divertacle envelops the cerebellum and meets its fellow of the opposite side. In a short time this sac flattens out, and both layers fuse with the ectal surface of the cerebellum, and constitute a temporary proliferating organ from which the cells are derived. These cells migrate to a point beneath the layer of Purkinje's cells, the origin of which seems to be also from the ventricular epithelium. Although this process has been observed only in rodentia there can be no doubt that it prevails in other groups of mammals. Although somewhat unexpected, this method is not unlike that which Professor His has described for the origin of the olives and related structures of the medulla. By this provision the increase of ectal surface through the convolutions of the cerebellum provides for the largest possible enlargement of the active centres with the most economical distribution of fibres.

This discovery may serve to enforce the value of a comparative method in approaching a complicated problem like the present one.

C. L. HERRICK.

JOHN GILMER SPEED follows up his article in the September *Lippincott's* with a paper entitled "The Common Roads of Europe." He shows how far ahead of us the great nations of Europe are in the matter of roads and their administration and maintenance. Among other articles in the October number may be mentioned a paper by William Agnew Paton upon "The Lost 'Landfall' of Columbus."

ANTHROPOLOGY PAST AND PRESENT.[1]

[Continued from p. 172.]

IT has been the custom to speak of the early Aryan, Semitic, and Turanian races as large swarms — as millions pouring from one country into another. It has been calculated that these early nomads would have required immense tracts of meadow land to keep their flocks, and that it was the search for new pastures that drove them, by an irresistible force, over the whole inhabitable earth.

This may have been so, but it may also have not been so. Anyhow, we have a right to suppose that, before there were millions of human beings, there were at first a few only. We have been told of late that there never was a first man; but we may be allowed to suppose, at all events, that there were at one time a few first men and a few first women. If, then, the mixture of blood by marriage and the mixture of language in peace or war took place at an early time, when the world was peopled by some individuals, or by some hundreds, or by some thousands only, think what the necessary result would have been. It has been calculated that it would only require six hundred years to populate the whole earth with the descendants of one couple, the first father being dolichocephalic and the first mother brachycephalic. They might, after a time, all choose to speak the Aryan language, but they could not choose their skulls, but would have to accept them from nature, whether dolichocephalic or brachycephalic.

Who, then, would dare at present to lift up a skull and say this skull must have spoken an Aryan language, or lift up a language and say this language must have been spoken by a dolichocephalic skull? Yet, though no serious student would any longer listen to such arguments, it takes a long time before theories that were maintained for a time by serious students, and were then surrendered by them, can be completely eradicated. I shall not touch to-day on the hackneyed question of the "home of the Aryans" except as a warning. There are two quite distinct questions concerning the home of the Aryans.

When students of philology speak of Aryans, they mean by Aryas nothing but people speaking an Aryan language. They affirm nothing about skulls, skins, hair, and all the rest. Arya with them means speakers of an Aryan language. While, on the contrary, students of physiology speak of dolichocephalic, orthognathic, euthycomic people, they speak of their physiological characteristics only, and affirm nothing whatever about language.

It is clear, therefore, that the home of the Aryas, in the proper sense of that word, can be determined by linguistic evidence only, while the home of a blue-eyed, blond-haired, long-skulled, fair-skinned people can be determined by physiological evidence only. Any kind of concession or compromise on either side is simply fatal, and has led to nothing but a promiscuous slaughter of innocents. Separate the two armies, and the whole physiological evidence collected by D'Omalius, D'Halloy, Latham, and their followers will not fill more than an octavo page; while the linguistic evidence collected by Benfey and his followers will not amount to more than a few words. Everything else is mere rhetoric.

The physiologist is grateful, no doubt, for any additional skull whose historical antecedents can be firmly established; the philologist is grateful for any additional word that can help to indicate the historical or geographical whereabouts of the unknown speakers of Aryan speech. On these points it is possible to argue. They alone have a really scientific value in the eyes of a scholar, because, if there is any difference of opinion on them, it is possible to come to an agreement. As soon, however, as we go beyond these mere matters of fact, which have been collected by real students, everything becomes at once mere vanity and vexation of spirit. I know the appeals that have been made for concessions and some kind of compromise between physiology and philology; but honest students know that on scientific subjects no compromise is admissible. With regard to the home of the Aryas, no honest philologist will allow himself to be driven one step beyond the statement that the unknown people who spoke Aryan languages were, at one time,

[1] Address before the section of Anthropology of the British Association for the Advancement of Science, at Cardiff, August, 1891, by Professor F. Max Müller, president of the section (Nature, Sept. 3).