II. "Contributions to the Anatomy of the Central Nervous System in Vertebrate Animals. Sub-section I. Teleostei. Appendix. On the Brain of the Mormyridæ." By ALFRED SANDERS, M.R.C.S. Communicated by Professor HUXLEY, LL.D., F.R.S. Received February 16, 1882.

(Abstract.)

The author, after a preliminary sketch of the literature of the subject, and a description of his method of hardening and staining, proceeds to give an idea of the external aspect of the central nervous system in the Mormyridæ.

Taking as an example the brain of the *Hyperopisus dorsalis*, he describes it as comparable to that of an ordinary teleostean fish to which two additions have been made, namely, an organ situated in the region in front of the cerebellum, which grows out in the form of plates, from a pair of stalks. These plates, or wings as they may be termed, become folded in every direction, and breaking through the tecta lobi optici, and repressing them to the base of the brain, they cover over all the remaining lobes of that organ.

It is only the tecta lobi optici which undergo displacement, the tori semicirculares retain nearly their usual position, so as to become related to the former as an egg to the egg-cup, or an oyster to its shell.

On the outer side of the plates are minute ridges running mostly longitudinally, in close proximity to each other; the parts where these ridges become external are of a pinkish colour when fresh, but where the plates are folded on themselves, the inner side of the wings becomes external, and shows a white colour under the same circumstances.

These folds take place when the plates have grown sufficiently to reach the walls of the skulls, and are arranged as follows:—the plate which grows towards the anterior end of the skull turns backwards; that which grows towards the summit of the skull turns inwards; that which grows outwards turns upwards, while that which grows backwards ends in a free edge, and conceals the second of the additional parts alluded to above.

This exists in the form of a large nearly spherical tuberosity placed behind the cerebellum, in or over the region of the fourth ventricle.

The author then gives an account of the microscopic anatomy of this brain. Passing lightly over the remainder of the lobes, which resemble in structure those of the ordinary teleostei, and noticing in passing that the composition of the tecta lobi optici is much simplified, he proceeds to describe the structure of the cerebellum. He finds that

this presents the four layers usually found in the corresponding lobe in the teleostei, namely, counting from the outside, the molecular, the intermediate—which includes the Purkinjé cells—the granular, and the fibrous; the latter consisting of nerve-fibres on their way to the crura cerebelli.

Noticing Denissenko's* paper, and his discovery of two species of cells in the granular layer of the cerebellum, the author remarks that he was unable to find them, even by using Denissenko's own method. He then discusses the cause of the striation in the molecular layer, which he attributes in a great measure, but not entirely, to prolongations from the epithelial layer of cells which cover the surface of the cerebellum. Incidentally he mentions that he has traced an axis cylinder process of a Purkinjé cell into a medullated nerve-fibre.

He then goes on to describe the structure of the organ in front of the cerebellum. This he finds consists of two parts, a central continuation of the cerebellum, having precisely the same structure and arrangement, and two lateral parts spreading out one on each side, like wings.

The plates which form these lateral wings consist of minute cells, resembling those found in the granular layer of the cerebellum. Each ridge has four layers corresponding to those found in the cerebellum, arranged in a slightly different manner. The molecular layer comes first, then the granular and intermediate layers mingled together, and last of all, the fibrillæ from the fibrous layer. The molecular layers of contiguous ridges are placed in close contiguity with a process from the pia mater interposed between them; the granular and intermediate layers come next, consisting of cells of different sizes, connected together by a network of fibrillæ. The smaller cells resemble those of the granular layer of the cerebellum; the larger ones are intermediate between the last, and the Purkinjé cells to which they lead up. These latter are arranged in a single layer; they are smaller in size than the corresponding cells in the cerebellum, and usually oval or fusiform in shape; they generally have two processes, one, the protoplasmic process, directed towards the molecular layer, and the other the axis-cylinder process, turned towards the bundle of fibrillæ which is derived from the fibrous layer, and which, passing between two contiguous ridges on the side opposite the molecular layer, forms the boundary between them.

In some parts, however, these cells are arranged in groups, viz., where the bending of the wings causes bays and recesses in the ridges; here they are polygonal in shape and present several processes. The sides of the ridges are inserted into the plates or wings of granular layer cells, by conical processes.

* "Zur Frage ü. d. Bau d. Kleinhirnrinde," "Arch. f. Mik. Anat.," Bd. xiv, 1877.

The large tuberosity situated behind the cerebellum is termed by the author the tuberculum impar, and consists of six layers, counting from the outside.

1. The first layer has small cells which become deeply coloured by the staining fluid.

2. The second contains sections of obliquely directed nerve-fibres.

3. The third is smoothly granular and does not become so highly coloured as the outside layer, but shows faint indications of radial striations.

4. The fourth is a narrow stratum of moderately sized cells of varying dimensions, which become intensely coloured by the staining fluid.

5. The fifth consists of a complex of nerve-fibres.

6. The sixth layer only found at the anterior end of the tubercle is composed of finely granular material; the corresponding portion of the posterior end is occupied by a circular space.

In addition to these six layers there is intercalated between the first and second layers a body of granular neuroglia, in which extremely large cells are collected; at the anterior end of the tuberculum impar, this structure takes the place of the first layer and becomes interposed between the tubercle in question and the cerebellum.

The author then discusses the modes of origin of the nerves which are present in these fishes. The trochleares and the abducentes appear to be absent. The trifacial and the vagus, in addition to their ordinary origins, derive the greater number of their fibres from the tuberculum impar, the former from the anterior end, the latter from quite the posterior edge. The facial and the glossopharyngeal are parts of these two nerves respectively.

The author finds, contrary to the opinion of Bellonci,* that the optic nerve has an origin from the hypoarium as well as from the tecta lobi optici. The other nerves arise as in Teleostei.

The author then proceeds to indicate the probable homologies of these two extraordinarily developed organs. Taking the brain of a Ballan wrasse (*Labrus maculatus*) and examining the part which is generally termed the valvula cerebelli, he finds that it has a central part resembling the cerebellum in structure, together with a wing on each side, occupying much more of the ventricle of the optic lobe than in many other Teleostei.

These wings are formed by an extension of the molecular layer of the central part, which even here shows two or three folds based on an extension of the granular layer. He therefore puts forward the idea that if these wings of the valvula cerebelli of the *L. maculatus*

* "Ueber d. Ursprung des Nervus Opticus und den feineren Bau des Tectum Opticum." "Zeitsch. f. Wiss. Zool.," Bd. xxxv, 1880.

were to continue to increase indefinitely, an organ resembling the highly developed structure in the Mormyridæ would result. This latter then may be looked upon as homologising with the valvula cerebelli and its wings in the ordinary teleostean.

With regard to the body which is placed behind the cerebellum, the author points out that the Cyprinidæ possess a well-known tuberosity occupying a corresponding position, which is termed by writers the tuberculum impar; this, in conjunction with the vagal tuberosities of the medulla oblongata, presents layers comparable to those existing in the structure in question belonging to the Mormyridæ; he therefore suggests that the homology of this exaggerated tuberosity in these fishes is to be looked for in the tuberculum impar together with the vagal tuberosities of the Cyprinidæ, the increased size in the former species having caused it to include the origin of the trifacial in addition to that of the vagus.

In conclusion, the author offers some criticism of the ideas lately put forward by Fritsch* as to the homologies of the various parts of the brain in fishes, the key to the whole of which lies in his interpretation of the tecta lobi optici, which he takes to be the persistent cortex of the primary anterior vesicle† of the brain of the embryo, and consequently to belong to the thalamencephalon, and not to the mesencephalon.

In reply to this the present writer points out that the homologies of all the other parts of the brain in Teleostei may be deduced from the position of the pineal gland, the infundibulum, and the ganglion of origin of the oculomotorius.

From this line of argument he maintains that the tecta lobi optici correspond to the anterior pair of the corpora quadrigemina, and consequently belong to the mesencephalon, and not to the thalamencephalon. Finally he remarks that the brain in Teleostei would not be in accordance with the remainder of their organisation, if all the parts of a mammalian cerebrum could be distinguished in it, even in a comparatively rudimentary state as is maintained by Fritsch.

III. "On the Spectrum of Carbon." By G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge. Received February 23, 1882.

The spectroscopic investigations we have communicated to the Society "On the Reversals of the Lines of Metallic Vapours," have

* "Unters. ü. d. feineren Bau des Fischgehirn." Berlin, 1878.

† "Primäres Vorderhirn," *loc. cit.*