

THE CENTRAL NERVOUS SYSTEM OF PROTOPTERUS ANNECTENS.

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Of the former investigators, who have dealt with the central nervous system of *Protopterus annectens*, only one, namely, Füllignet, considers the microscopical anatomy. The work of this author is in many respects incomplete, especially as compared with the descriptions of the anatomy of other vertebrate brains. I have, therefore, ventured to subject it to another investigation.

The spinal cord shows the following structure: The disposition of the white and gray matter is as in Amphibia, in the anterior horn are found very large ganglion cells, the processes of which extend dorsad into the white substance, large cells are also found in the lateral portion of the gray substance. For the first time in the development of the animal kingdom, a substantia gelatinosa of Rolando is seen. Isolated neuroglia cells are found in the white substance, giving support to the fibres. The nerve roots pass out alternately, as has been often noticed in many of the lower vertebrates. A ligamentum denticulatum is found on each side of the cord.

The medulla oblongata is very simple in its structure and shows a slight flexure. From it are given off the following nerves:

1. The hypoglossal, with two ventral roots;
2. The vagus, with seventeen roots, of which three are ventral and fourteen are lateral;
3. The glossopharyngeal, with two large roots;
4. The fasiali-acusticus, with six roots;
5. The trigeminus with two roots.

The cerebellum is composed of a fold similar to the one found in the amphibia, though a little better developed. The nervi trochlearis and abducens, which have hitherto been unnoticed in the Dipnoi, were also found.

The mid-brain shows a layer of cells in the periphery, the axis cylinders of which pass into the opticus, otherwise its structure is very much as that of the mid-brain of Amphibia. The most important differences between the brain of Protopterus and that of the lower vertebrates is found in the primitive fore-brain. The roof of the diencephalon, which entirely escaped the notice of Füllignet (no doubt by reason of the imperfect conservation of his material) shows a complicated structure and forms a link between the amphibian brain and that of the Selachii. Just in front of the post-commissure is found the epiphysis with a structure like that described by Ehlers for the Selachii; its free end is attached to the frontal bones by means of the arachnoid, and at this point the cartilagenous skull shows a perforation. That portion described by Wiedersheim, Huxley and others as the epiphysis, is in reality composed of three parts, namely: 1, the "Zirbelpolster" of Edinger; 2, the velum, which represents a primitive form of the plexus choroideus medius; 3, the conarium (Adergeflechtknoten of Goette), which may also be looked upon as showing a primitive condition. The lower surface of the diencephalon exhibits two small, yet always easily demonstrable lobi inferiores [hypoaria]. The hypophysis is composed of a glandular and nervous portion.

The fore-brain shows exceptional development. There exists a posterior ventral portion, which according to its structure must be regarded as the lobus hippocampus. In it cells are found which correspond in form to those found in the fascia dentata of the mammalian brain; fibres which connect them with the lobi inferiores are also seen. In the entire pallium of the fore-brain, there exists a layer of ganglion cells which have been separated from the central grey matter and lie in the white. Another thin layer, found only in the anterior part of the fore-brain, send fibres into the lobus [tuber?] olfactorius. Contrary to the views of Füllignet I must state that a lobus olfactorius exists and is everywhere marked off from the other portions of the brain, by a fissure. The nervous trunk which leaves this lobe is, for a short distance, divided into a dorsal and a ventral portion, only to unite again before it reaches the olfactory membrane. Ventrad of the lobus olfactorius there is found a distinct elevation such as may be well seen in selachian brain; for

it I suggest the name, lobus post-olfactorius [post-rhinal lobe of Herrick Ed.] The lobe is found in the Amphibian brain, but in a much reduced condition and correspond to what His describes as the lobus olfactorius posterior in the human embryo, forming the substantia perforata in the adult brain. The arachnoid is developed only in certain regions, in the region where the "adergeflecht" [plexus choroideus] is united to the bony skull, again near the epiphysis. Over the fourth ventricle a saccus endolymphaticus is found, which spreads itself widely over the roof, and in it otoliths have been found. This sac is not in communication with the central cavity of the spinal cord.

Taken in general, we may regard the brain of *Protopterus* as a link between the amphibian and selachian brain, especially when the fore- and mid-brain are considered. In a monograph on the central nervous system of *Protopterus annectens*, which is now in preparation, the observations here recorded will be more carefully and more fully detailed.

PLATE XIII.

Fig. 1. Median longitudinal section of the brain of *Protopterus annectens*. Enlarged five diameters.*

Fig. 2. Ventral view of the same. x2.

Fig. 3. View from the right side. x4.

Fig. 4. Dorsal view of same. x4.

i—x, cranial nerves, *v, l, d*, ventral, lateral and dorsal roots respectively; *Com. ant.* präcommissura; *Con.* conarium; *Di.* diencephalon; *Epf.* epencephalon; *Hyp.* hypophysis; *L. inf.* lobi inferiores; *Lob. hyp.* lobi hippocampi; *Lob. pol.* lobus postolfactorius [postrhinalis]; *M. sp.* medulla spinalis; *Mes.* mesencephalon; *Met.* metencephalon; *Opt.* optic nerve; *Pros.* prosencephalon; *Pl. vent. IV.* metaplexus; *Tr. ol.* tractus olfactorius; *Tub. ol.* tuberculum olfactorium; *Z.* epiphysis.

*During reproduction this plate has been somewhat reduced.