4. On the cranial ganglia and segmental sense organs of Fishes.

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eingeg. 25. Februar 1885.

In the following lines a brief account is given of some new facts as to the development of the cranial ganglia and segmental sense organs, and also as to the relations of the cranial ganglia to segmental sense organs.

The justification for a second preliminary note on the segmental sense organs I find in the fact that my friend Mr. W. Baldwin Spencer, B. A. Scholar of Exeter College, Oxford, recently informed me that some of my discoveries in Elasmobranchii exactly agreed with the results of his own independent researches on the development of Amphibia.

In point of fact we have independently discovered the mode of origin of cranial ganglia which I detail below.

Mr. Spencer having written an account of his researches for the April number of the Quart. Journ. of Microsc. Sci., I now give a summary of my own work on the development of *Torpedo ocellata* merely premising that the full description with figures will be published with as little delay as possible.

At the outset it must be noted that what follows only refers to the true cranial nerves and their ganglia, — more correctly only to the posterior roots and their ganglia, which in their mode of development present more primitive features than the spinal nerves and ganglia.

It is generally accepted that in Elasmobranchii the posterior roots of the cranial nerves like those of the spinal, arise as outgrowths of a ridge of cells, which lies on each side of the dorsal edge of the neural canal, — this is the neural ridge of Marshall. The neural ridge lies in the angle between the neural canal and the external epiblast, just beneath and in close connection with the latter.

Local outgrowths of cells of this ridge grow outwards and downwards, towards the lateral surface of the body and form the rudiments of the posterior roots. In their course they lie directly under the epiblast. All this is well known. But I find that the subsequent events are as follows.

1) When these outgrowths reach the level of the nolochord they fuse with the epiblast.

2) At this point of fusion of any one cranial nerve with the skin a local thickening of the epiblast takes place. On this a proliferation of some of the cells composing the thickening ensues. The proliferated cells form a mass made up of actively dividing elements still connected with the skin and fused with the posterior root.

3) This mass of cells is the rudiment of the ganglion of a posterior root of a cranial nerve[1].

For some time cells continue to be given off form the thickened epiblast —, and of those already given off many show nuclear figures, indicating rapid division.

Thus in the end a fair sized ganglion is formed, but it is still intimately connected with the skin.

4) But this is not all: the portion of thickened epiblast at which a ganglion is formed is also the point of origin of one of the segmental sense organs.

In fine, the first segmental sense organs of the head and the cranial ganglia are formed in intimate connection.

The importance of this fact cannot be overestimated. It shows so close a relationship between the segmental sense organs and segmental ganglia of the head that in all future work dealing with the posterior roots of cranial nerves this relationship will have to be taken into account.

It further justifies the endeavours which have been made (Eisig) to attach morphological importance to the segmental sense organs.

Moreover I think the time is past, if it ever existed since Leydig's brilliant researches, when zoologists can with any pretence to morphological accuracy and meaning speak of these important sense organs — viz. the segmental sense organs, — as mucous canals.

5) At a later stage the ganglion separates from the skin, only remaining connected with its segmental sense organ by a small nerve branch, which also in all cases is split off from the skin.

The mode of origin discribed above holds for the ganglia of the following segmental nerves, fifth, seventh, eighth, ninth and tenth, and also for the ciliary ganglion. I leave out of question for the present what is the posterior nerve root of the latter ganglion.

I have not yet quite satisfied myself that the olfactory ganglion arises in this way, but my own researches, incline me towards the affirmative, an inclination which is much strengthened by careful perusal and examination of Prof. Marshall's paper and figures on the Morphology of the Olfactory organ[2].

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[1] Mr. Spencer has quite independently discovered this mode of origin of cranial ganglia in Amphibia. In point of time perhaps even before me. — It is very probable that such a mode of origin occurs in *Teleostei*. Indeed, I was led to suspect it in *Salmo* some two years ago.

[2] Marshall, The Morphology of the Vertebrate Olfactory organ. Quart. Journ. Microsc. Sci. Vol. XIX. 1879. p. 300.

In certain of the figures a number of cells forming the rudiment of the olfactory ganglion are drawn in intimate connection with the epiblast thickening which forms the olfactory pit (Fig. 19 and 20).

It has been stated above that the nerve connecting any cranial segmental ganglion with its corresponding segmental sense organ is derived from the skin. This is also the care with the nerve connecting the compound vagus ganglion with the various segmental sense organs of the trunk, — that is, the so-called lateral nerve. This mode of origin was ascribed to it by Semper, Goette, van Wijhe and Hofmann. My former account in which I supported Balfour's view is, at any rate in part wrong.

In my former note[3] I put forward the view that the auditory nerve was merely a modified segmental sense organ, and as a natural corollary to this that the auditory nerve was a segmental nerve (posterior root.) The latter view, though not directly stated, was a natural inference. I however overlooked the fact that van Wijhe[4] had furnished independent evidence for regarding the auditory nerve as a segmental nerve, he did not however hint at any morphological connection between the auditory organ and segmental sense organs.

I was further unaware of a paper of Mayser's[5] (for a knowledge of which I have to thank Prof. Wiedersheim) in which among other things the conclusion is drawn that the segmental sense organs, so-called »Schleim-Canäle« form an accessory auditory organ. This view is based upon the close connection in the brain of the auditory centre and centre of origin of the nerves supplying these sense organs.

The olfactory nerve has been classed among the segmental nerves by Marshall[6], who has furnished a good deal of evidence for such a conclusion. If the probability of the olfactory ganglion arising like the other cranial ganglion as a proliferation of the epiblast, be converted into a certainty, then while accepting fully Prof. Marshall's view of the segmental nature of the Olfactory nerve, the question will have to be considered whether the sense organ which arises in connection with the olfactory ganglion is not the homologue of the sense organ which arises with any other cranial ganglion — that is the homologue of a segmental sense organ.

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[3] Zool. Anzeiger 1884. No. 161—162.

[4] Van Wijhe, Über die Mesodermsegmente und die Entwicklung der Nerven des Selachierkopfes. Amsterdam, 1882.

[5] Mayser, Vergleich. Anat. Studien über das Gehirn der Knochenfische etc. Zeitschr. f. wiss. Zool. 36. Bd. p. 259.

[6] Op. cit.

This would lead not to a rejection but to a modification of the view put forward by Prof. Marshall that the olfactory organ is a modified gill-cleft. It would then have to be regarded rather as the modified sense organ of a gill-cleft — and in fact as the most anterior of the segmental sense organs.

For the present, I leave the matter here.

Another of the many conclusions to be drawn from my researches is one as to the number of segments contained in the vertebrate head. Marshall[7] and van Wijhe[8] have each recognised five segments in front of the vagus. But they differ in that Marshall's first segment is the olfactory, and he does not consider the auditory nerve as a separate segmental nerve, while van Wijhe's first segment is the one containing the ciliary ganglion, he rejects the olfactory segment, and recognises a segment in the auditory region, represented by the auditory nerve. My own results drawn from a study of the segmental sense organs would lead to the conclusion that there are six segments in front of the vagus, represented by the following nerves, olfactory, motoroculi (ciliary ganglion), fifth, seventh, eighth, and ninth. Further, since the vagus is known to represent at least four roots, counting these there would be at least ten segments in the vertebrate head, each possessing a segmental sense organ.

With this, I conclude for the present, leaving all other inferences for the complete paper.

Manchester, 20th February 1885.

III. Mittheilungen aus Museen, Instituten etc.

1. Toluol statt Chloroform bei Paraffineinbettung.

Von Prof. Dr. M. Holl in Innsbruck.

eingeg. 16. Januar 1885.

Die Behandlung der Objecte (sobald sie nur etwas größer sind und etwas dichteres Gefüge haben) mit Chloroform, um sie für die Paraffineinbettung tauglich zu machen, hat sehr leicht ein Mißlingen im Gefolge, ja für manche Objecte (mit sehr dichter und derber Textur) kommt man mit Chloroform nie zum Ziele. Die ganze Procedur dauert ziemlich lange und man hat bei Objecten, welche im Chloroform nicht untersinken sondern schwimmen (bei den meisten ist

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[7] Op. cit.
[8] Op. cit.