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## II. Wissenschaftliche Mittheilungen.

### 1. On the Segmental Sense organs of the lateral line, and on the Morphology of the Vertebrate Auditory organ.

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(Schluß.)

eingeg. 22. Dec. 1883.

Thus it is seen that all the segmental nerves in front of the vagus have dorsal branches for the supply of segmental sense organs.

From this point the matter is no longer so simple; we have now to deal with a nerve complex. It is merely repeating a well known fact in stating that the vagus is formed by the fusion together of at least six segmental nerves.

In *Scyllium* and *Pristiurus* (Van Wijhe) the vagus is formed by the fusion of three primitive roots, and hence in this case represents at least three segmental nerves. In *Notidanus* and in *Marsipobranchii*

the vagus supplies six posterior branchial clefts, and must therefore be equivalent to at least six segmental nerves (Marshall). As a natural result of this partial fusion of the main roots of the original nerves, a reduction of the number of dorsal branches to the segmental sense organs, due in turn to the fusion of these branches, takes place.

Van Wijhe finds three dorsal branches in *Scyllium* and *Pristiurus*, one for each root of the vagus. The first of these, Ram. supratemporalis, which also forms a separate »lateral nerve« in the adult »entsteht durch die Verschmelzung des Ram. I. vagi mit einer isolirten Epidermisverdickung, welche später sowohl einen Theil des Hauptschleimcanales als der supratemporalen Quercommissur zu bilden scheint« (Van Wijhe). According to the same author the main lateral nerve arises as a single nerve from the 2nd and 3rd ramus of the vagus.

In Teleostei this fusion has gone much further, there is only one lateral nerve given off by the vagus.

But as seen above in Elasmobranchii traces of a primitive condition of the lateral nerve exist, — of a condition in which there was for each root of the vagus a dorsal branch supplying the sense organs of its segment.

From this point to the end of the body no traces are to be found of segmental branches to the segmental sense organs, and what we have instead is the remarkable phenomenon of a sensory branch of a cranial nerve fusion (the vagus) supplying fibres to sense organs which extend to the extreme posterior end of the body. How did this condition of things arise? The sense organs of the lateral line in the body are just as segmentally arranged as those in the head. The only difference obtains in the nerve supply, for in the head the nerve of each segment gives off a dorsal branch to supply its corresponding pair of sense organs, in the body there is only one nerve stem to all the sense organs.

The explanation of the condition of things is to be looked for in the partial fusion of the segmental nerves which form the vagus. Through this fusion, which as shown above takes place from behind forwards, a corresponding fusion of the dorsal sensory branches of the constituent nerves took place, and thus a lateral nerve or more than one was formed, which innervated more than one pair of sense organs. Hence the vagus complex obtained a greater share in the innervation of the lateral line.

The dorsal branches of segmental nerves in the body, in accordance with Döhrn's principle of change of function, gradually lost their function of innervating segmental sense organs, and this function was

taken up by the lateral nerve formed from the vagus complex. This change was probably assisted by an anastomosis between some of the terminal fibres of neighbouring dorsal sensory branches. Some remains of this anastomosis perhaps still exist in the fibres described by Bodenstein and Solger as connecting neighbouring sense organs.

Thus it appears that in Vertebrates there are segmental sense organs or Seiten-Organen which were primitively innervated by special segmental branches of the segmental nerves, that many of these special branches have disappeared, and the innervation has become complex; but that in the segmental character of the organs, in the persistence of many of the dorsal branches supplying these organs, in the conditions of nerve supply obtaining in embryonic Elasmobranchii, and in the essential histological agreement between the Vertebrate side organs and those of Annelida, especially Capitellidae (Eisig), there seems to be evidence sufficient for the opinion, first put forward by Eisig, that the Vertebrate side organs and those of Annelida are fundamentally homologous.

It is perhaps hardly necessary to point out the value of such a fact in supporting the theory of the Annelidan origin of Vertebrates advocated by Dohrn and Semper.

#### Morphology of the Vertebrate auditory organ.

Before concluding this »Vorläufige Mittheilung« attention must be directed to another Vertebrate sense organ, the ear.

The chief vertebrate sense organs have certainly had a very different origin. The olfactory organ is probably a modified gill (Marshall). The eye is developmentally and really part of the brain. Such a view was also once held with regard to the olfactory and auditory nerves as well as the eye. But recent researches, especially those of Marshall and Van Wijhe, have proved that the auditory nerve is merely a dorsal sensory branch of the 7th cranial nerve (3rd segmental nerve of Van Wijhe).

It has been shown above that the nerves which supply the segmental sense organs are dorsal sensory branches of the segmental nerves, that the segmental sense organs are merely modified portions of the epiblast, that these sense organs primitively, and in some existing form still throughout life, lie free on the surface of the body, but that later in most cases they become shut off from the epidermis in a sac which remains connected with the external world by a small opening. The sensory cells of these organs possess long fine terminal hairs, which are easily affected by wave-motions in the medium in which the animal lives, and which communicate this wave motion to the nerves



connecting them with the brain. Do we really meet with this condition of things in the auditory organ? In other words, is the auditory organ merely a specially modified portion of the system of segmental sense organs?

The auditory organ is, like the segmental sense organs, really a modified portion of the epiblast. Very early in development it becomes shut off in a sac from the epidermis, a condition which only arises later in the segmental sense organs.

The semicircular canals etc. are clearly secondary complications, for in every embryo the auditory organ is at first a simple sac shut off from the epidermis, of which sac a portion of the inner wall consists of two layers of modified epiblastic cells, connected by a dorsal sensory branch of a segmental nerve with the brain.

This double layer of modified epiblastic cells is in every way comparable to a segmental sense organ. As in the latter the cells on the free surface possess long hairs. These hairs like those of the segmental sense organs are concerned with the perception of wave-motions of the medium in which the animal lives. The hairs on the auditory cells are indeed concerned with the perception of much finer wave-motions, — those of sound, — than those on the cells of the segmental sense organs, and hence arises the early shutting off of this organ from the skin. The inner layer of cells of the auditory organ is exactly comparable to the inner layer of cells of a segmental sense organ.

In Teleostei etc. the auditory organ becomes entirely shut off from the skin, but in Elasmobranchii the aperture of invagination persists, and the organ is connected with the surface throughout life, just as the segmental sense organs.

These facts, together with the fact that the auditory nerve is merely a dorsal sensory branch of a segmental nerve seem to point to the conclusion that the auditory organ of Vertebrates is fundamentally a specialized portion of the system of sense organs of the lateral line, specialized above the rest of the system by the acquirement of the more delicate function of the perception of waves of sound.

In accordance with, and as a direct consequence of, this function of receiving waves of sound the auditory organ has been early shut off from the external surface, and has developed accessory structures in the shape of semicircular canals etc. Thus its primitive simplicity has been lost.

I hope shortly to give elsewhere a more detailed statement of the points touched upon in this paper.

Naples, Dec. 16th 1883.

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