Reviews and Notices of Books.

Das Gehörorgan der Wirbelthiere—Morphologische histologische Studien. Von GUSTAF RETZIUS, Professor, &c., in Stockholm. Folio, Stockholm. Feb. 1881. 1. *Das Gehörorgan Fische und Amphibien* (with 35 plates).

WE regret having been so long giving a notice of this important work which may be regarded as a masterpiece in its department of Comparative Anatomy. It is dedicated to the memory of the author's illustrious father, Andreas Retzius, and certainly no more appropriate tribute could be offered by his son to the untiring genius for research of that most able and amiable anatomist.

This part forms the first instalment of a complete work on the organ of hearing in vertebrate animals which its author had planned as early as 1871, but which at one time he had almost been inclined to abandon after the publication of several of the admirable memoirs of Hasse on the same subject. But fortunately for science he was led to continue his observations and to bring them together for publication; and it may be confidently hoped that the second part of the work may, according to the author's expectation, ere long appear. The part at present under review comprehends fishes and amphibia, and the remaining part will embrace reptiles, birds, and mammals.

The work presents all the characters of having been executed with great care, both as regards the 220 pages of descriptive text, and the 35 beautiful plates, containing in each on an average between 13 and 14 figures, and in the careful reference letters and description. In fact it may be looked upon as a model for such works both by the clear description of the large amount of original works which it affords, and by the copious reference to the other researches the publication of which has preceded that of the author.

Through the kindness of a number of his friends and correspondents and his own opportunities, the author was enabled to include in his investigation and description as many as 48 fishes and Dipnoi and 15 Amphibia; and he promises the description in the succeeding volume of 22 reptiles, 10 birds, and several mammals.

The following is an abstract of the principal statements made by the author in the first part of his treatise:

In the Cyclostomata the structure of the organ of hearing stands so much below that of other fishes that it scarcely admits of comparison with them. In Myxine there is a sacculus communis

with one semi-circular canal (external) and two ampullæ; but while the saccus may be compared to the sacculus of other animals, the single canal may perhaps rather represent the utriculus.

In *Petromyzon (fluviatilis)* there are two semi-circular canals corresponding to the anterior and posterior of higher animals, with two ampullæ presenting a peculiar trifold subdivision, the middle part of which in each corresponds to the true ampulla and presents the *crista acustica*. The commissure of the two canals is probably the same as in other animals, but the nature of the vestibule is somewhat doubtful. There is probably an aqueduct of the vestibule or endolymphatic duct, and it may be that the elongated macula acustica combines those of the recessus utriculi, the sacculus and the lagena cochleæ; but as these are not separate some doubts may exist regarding them, and there is thus a considerable gap between the structure of the hearing organ in *Cyclostomata* and that of other fishes.

Among the remaining fishes, various as is their structure in many other respects, it is surprising what general similarity prevails in the structure of the hearing organ.

Among the Ganoids, *Acipenser* is the forerunner of the Osseous ganoids (*Lepidosteus*) on the one hand, and of the Teleostei on the other, but in the structure of the labyrinth it comes very near to the Teleostei. A large *canalis utriculo-saccularis* and a *ductus endolymphaticus* are present. The otoliths have not yet acquired the hardness which they possess in Teleostei.

In the Osteoganooids there are true hard otoliths. The lagena is only slightly separated from the sacculus. The endolymphatic duct is wide and ends as a cæcum superiorly.

The variations in the form of the hearing organ in Teleostei are so great that it is difficult at first to reduce them to one type, but a closer examination shows them to be essentially similar. Hasse has distinguished two types among them, viz. 1, that of the Perch, and 2, that of the Cyprinoids; and there is perhaps a third also, viz. that of the Clupeidæ.

Great variation in the size of the sacculus is to be found: it being very large in *Gobius* and *Trachinus*, very small in *Leus*, and reduced to a minimum in *Exocetus*. The lagena also is very variable; in *Esox* and *Belone* it is scarcely separated from the sacculus, in others as *Pagellus*, *Scomber*, *Clupea*, forming a considerable bursa-like swelling, and again in others, as *Gadus*, *Lophius* and *Raniceps*, flask-like and opening into the sacculus by a narrow tube.

In the *Lophobranchii* (*Siphonostoma*, *Hippocampus*) the sacculus is not separated into an upper and lower part, and this contrasts strongly with the disposition in *Anarrhicas* in which the two parts are nakedly distinct.

In connection with the *canalis communicans* or *utriculo-saccularis* Retzius finds, in confirmation of his previous researches and in opposition to the statement of Hasse, that in 11 of the 33 Teleostei described the communication exists. In *Clupea* and *Corregonus* it is just perceptible and in the remaining 20 it is

entirely absent. In two thirds of these fishes there was present the *macula acustica neglecta* described by the author in a previous work, while it is absent in eleven. It is singular that in allied tribes such differences should exist.

The form and structure of the otoliths would form an interesting subject if treated systematically; but the author has not been able to go into it farther than in connection with the other parts.

In the Elasmobranchs Retzius points out three very obvious types in the structure of the organ of hearing, viz. that of the Holocephali, of the skates, and of the sharks. The type of the Holocephali (*Chimæra*) forms an interesting transition to that of the Plagiostomes and through these to that of other fishes.

In all the Elasmobranchs the ductus endolymphaticus forms a pervious tube opening upon the surface of the head. In some it is straight and simple, in others it is narrowed or bent horizontally near its termination. There is also in all a separation of the recessus utriculi from the utriculus and from the outer and anterior ampullæ, which is remarkable as compared with the form in Ganoids and Teleostei.

In *Chimæra* there is only a small opening, and the anterior and outer ampullæ open into the utriculus directly and not into the recessus. In the sharks there is often a pretty long tube between the utricle and the saccule, and there are in other instances interesting gradations in the development of this canal.

The *macula acustica neglecta* is present in all the examples of this group of fishes examined by Retzius. In *Chimæra* it constitutes a small nerve termination situated at the hinder end of the *canalis utriculo-saccularis*; but in skates and sharks the position is different, in consequence of the separation of the utriculus and the superior sinus. In the Elasmobranchs, in contrast with what is observed in the Teleostei and the sturgeon, the *macula acustica neglecta* is single or undivided.

As regards the lagena, this part is not separated from the sacculus in *Chimæra*, and its papilla is still in connection with the *macula acustica* of the sacculus. In the skates and sharks on the other hand the lagena forms a distinct bursa-like swelling of the sacculus, its papilla being in the skates only notched off from the *macula acustica*, but distinctly separated in the sharks.

In the sharks and skates, as is well known, the cartilaginous ear capsule is separated from the cranial cavity by a wall, but in *Chimæra* there is no partition so that it is a part of the same cavity with the brain.

In the Dipnoi there are interesting relations which receive their explanation from the study of the Elasmobranchs and particularly of *Chimæra*. In *Ceratodus* and *Protopterus*, and more especially the last, we find a very large recessus utriculi, not communicating directly with the utriculus or with the anterior or outer ampullæ, but united by an oval canal, (*can. recessu-saccularis*) with the sacculus, and through its intervention by the *canalis utriculo-saccularis* with the utriculus itself. The anterior and outer ampullæ open as in Elasmobranchs into the anterior end of the utriculus.

The single or undivided macula acustica neglecta lies in the base of the utricle.

There is no distinct lagena cochleæ, but there is a separate papilla acustica lagenæ on the hinder and inner wall of the sacculus.

The endolymphatic duct was not found, and if it exists it certainly does not reach the surface of the head as in Elasmobranchs.

The utricle and its superior sinus are not divided vertically as in Plagiostomes. The ear cavity is, as in Teleostei, Ganoids and Chimæra, open to the brain cavity. The otoliths consist only of small separate crystals. The ear of Dipnoi differs therefore considerably from that of Ganoids, and approaches more nearly to that of Elasmobranchs, especially of Holocephali or Chimæra. It seems as if the Dipnoi together with the Holocephali constituted a common but later divided lateral branch of the "principal phylogenetic line." As regards the structure of their organ of hearing they cannot be placed, as was formerly attempted, in the same group with the Ganoids.

Between fishes and Amphibia there is of course in respect of the organ of hearing a gap not easily filled up; but yet not so great as might previously have been supposed:

In the lowest Urodeles the structure of the organ, as in Proteus, Menobranchus and Amphiuma, recalls forcibly that of Acipenser, although a separated lagena cochleæ exists in the Urodeles and there are other minor differences. They might be considered to have the properties of the Proganoids, which are inadequately represented, and the many intermediate members are unfortunately not known. With the divergent Dipnoi and Elasmobranchs on the other hand they have much less in common.

All the Amphibia, Urodeles as well as Anura, have the ear capsule closed on the inner or cerebral side by a partition wall. The lower Urodeles are especially characterised by the existence of a true perilymphatic space, limited by an external periosteal covering, and connected with the cerebral cavity by a tube (ductus perilymphaticus, Hasse) which passes through a special foramen. This space and its tubular outlet have nearly the same form in the higher Urodeles (Siredon, Salamandra), in which they were discovered by Hasse. The same observer also discovered the space and tubular outlet in the Anura, but in these animals the latter is dilated into a sack, and there also runs a long and somewhat complicated tube into the perilymphatic space where it opens.

In Urodeles and Anura, as in fishes, the ductus endolymphaticus proceeding from the sacculus goes, as shown by Hasse, through the apertura aquæductus vestibuli into the cerebral cavity, there to dilate into a comparatively large folded sack surrounding the brain but closed against the cerebral cavity.

The other morphological components of the membranous part of the organ of hearing in the lower Urodeles are the same as in fishes. There is a division into a superior and an inferior part, and these communicate with one another by means of a hole or tubular aperture, canalis utriculo-sacculus. Upon the projecting

median side of this opening there is in the lower Urodeles a small nerve-twig and termination (derived from the ramulus ampullæ posterioris) lying as in *Chimæra* and to some extent in *Plagiostomes* on the wall of the posterior canal, and this Retzius regards as certainly corresponding to the macula acustica neglecta of Elasmobranchs and other fishes.

As regards the true cochlear part there is not, with the exception of the lagena and its papilla acustica which are present in all amphibia (except *Cæcilia*), any further place of nerve termination in the lower Urodeles, as *Proteus*, *Menobanchus* and *Amphiuma*; but in the higher, as *Siredon*, *Menopoma*, *Pleurodeles*, *Salamandra* and *Triton*, there is the first appearance of a separate papilla acustica basilaris cochleæ. But Retzius does not agree with Hasse and Kuhn in describing this as a true basilar part of the cochlea with its cartilaginous framework. But in the *Anura* he states that there is a well developed and distinctly separated pars basilaris cochleæ, which has been well known, since it was described by Deiters and Hasse, with the papilla acustica and cartilaginous rim or border, the thinner wall of which Retzius regards with Hasse as corresponding to the membrana basilaris. He has not succeeded in finding transition forms between Urodeles and *Anura*, and he does not believe that such exist.

Retzius describes shortly the accessory parts of the organ of hearing in Amphibia, into the details of which it is not necessary to enter here. He calls attention to the peculiar saccularly dilated duct (ductus fenestræ ovalis), which in the frog runs from the perilymphatic space to the cartilaginous plate of the columella and projects in the fenestra ovalis, and to the fact that a similar duct or diverticulum of the perilymphatic space is already more or less developed in the other *Anura* and the higher Urodeles.

Throughout the whole work Retzius has given minute descriptive details of the histological structure of the terminal nerve apparatus and other parts, all of which are illustrated by clear and appropriate figures drawn by himself from microscopic specimens. Space does not admit of our following the author in this description, and as he means to return to the whole subject of the finer structure of the membranous labyrinth when he has completed his second volume, we shall probably have another opportunity of reverting to it.

Retzius concludes his description with a reference to a "phylogenetic line" or diagram which he has given, and in which the affinities of the several groups and genera are traced from the lowest point upwards and in diverging series. The principal line passes through the *Proamphibia*, *Urodeles*, *Posturodeles*, *Proreptilia*, and thence on to higher animals, and the successive lateral offsets from this line include the *Myxinoids* and *Petromyzons*, the *Proganoids*, *Sturgeons*, and *Osteoganoids* and the *Osseous fishes* on the one side; the *Dipnoi*, *Proselachii*, *Holocephali*, *skates* and *sharks* on the other, followed by *Proteus*, *Siredon*, *Triton*, and *Anura*.

ALLEN THOMSON.