

2. The lateral sense organs of Elasmobranchs. I. The sensory canals of *Laemargus*.

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In Elasmobranchs the lateral sense organs are represented by two systems of canals and by minute sensory follicles. The canals which open by numerous tubules on the surface of the skin, are in this paper spoken of as sensory canals, while those which give off neither tubules nor branches and are dilated at their proximal ends, are designated ampullary canals.

The general and comparative anatomy of the sensory canals of sharks and rays has been, during recent times, studied under the direction of Agassiz, first by Wilder and afterwards by Garman. The object of this investigation was chiefly to determine the value of the canals in classification. Studying the canals from this point of view has led to names being given to the canals irrespective alike of their innervation and development, with, amongst other results, the introduction of a somewhat arbitrary and complex nomenclature, and the breaking up of what is from certain points of view a single canal into several canals.

For example, the canal which is innervated by the ophthalmic division of the facial, consists, according to the Agassiz-Garman nomenclature, of three canals; while the canal related to the buccal division of the facial is described as six canals. In this paper the relations of the canals to the orbit, rostrum etc., have been regarded as of secondary importance, while special attention has been given to their innervation. Taking into consideration that the sensory canals seem to be developed, and from first to last continue, in connection with certain cranial nerves, it seems to me that the only logical way of dealing with them is to regard as all important their development and innervation.

This plan has already to a considerable extent been followed by Allis in his able paper on the lateral line system of *Amia*; and it is one which will, I venture to think, commend itself to future workers on the lateral sense organs of fishes.

According to this method there are altogether only four main sensory canals in Elasmobranchs, viz: the supra-orbital, infra-orbital, hyo-mandibular and lateral. All these canals are related to two nerves,

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the facial and vagus. The supra-orbital, infra-orbital and hyo-mandibular are related to the ophthalmic, buccal, and hyo-mandibular divisions of the facial, respectively, while the lateral is related to the lateralis division of the vagus.

In *Laemargus* the supra-orbital canal, beginning a short distance in front of the auditory pore, runs forwards above the eye and after penetrating the snout, and again returning to the dorsal surface to extend over the nasal capsule, it runs backwards under the head, to end by opening into the infra-orbital canal. It lies in, immediately under, or from 3 to 6 mm below the skin; is innervated by eighty branches from the superficial ophthalmic division of the facial, and opens on the surface of the skin by eighty-one short, slender tubules.

The infra-orbital canal, beginning in connection with the supra-orbital, runs outwards and forwards, first behind and then below the eye, and proceeds to the ventral surface, where after communicating with the supra-orbital and hyo-mandibular canals, it bends inwards towards the middle line. After forming a loop behind the nasal capsule, it communicates with the infra-orbital canal of the opposite side, and then on leaving its fellow, runs forwards to end blindly at the tip of the snout. This canal, which in some parts lies at a deeper level than the supra-orbital is innervated by eighty-seven branches from the buccal division of the facial, and opens on the surface by eighty-four tubules.

The buccal nerve also supplies about two and a half centimetres of the great longitudinal canal of the head and trunk. This short portion I have described as an accessory (otic) part of the infra-orbital canal, notwithstanding the fact that, instead of being continuous with the infra-orbital, it is continuous with the lateral canal. The otic portion begins one centimetre behind the terminal pore common to the supra-orbital and infra-orbital canals, and arches outwards and backwards. It is innervated by four twigs from a special (otic) branch of the buccal, and opens on the surface by four tubules.

The hyo-mandibular canal, very incomplete in *Laemargus*, occupies a nearly horizontal position at the side of the mouth. It communicates by its anterior end with the infra-orbital canal, and by its posterior end opens through the skin, and it receives eighteen branches from the hyo-mandibular nerve and gives off eighteen tubules.

The lateral canal I have described as consisting of three portions, 1) the trunk, 2) the commissural, and 3) the precommissural portions. The short precommissural part extends from the otic portion of the infra-orbital to the beginning of the temporal commissure; the commissural portion which runs inwards behind the auditory pore, meets and

unites with a corresponding portion from the canal of the opposite side, and thus forms the temporal commissure; the trunk portion runs backwards from the outer end of the commissure to terminate on a level with the end of the vertebral column, after making a characteristic bend above the lower lobe of the caudal fin.

The precommissural part receives two branches of the lateralis nerve, and gives off five tubules. The temporal commissure receives sixteen branches (eight from each lateralis nerve) and gives off sixteen tubules; while the trunk or main part of the lateral canal receives numerous branches from the lateralis nerve as it passes backwards along the trunk and tail.

The paper concludes by referring to the views held as to the function of the sensory canals, and to some of the modifications of the sensory canals found in Elasmobranchs.

Amongst other things it is pointed out that in some cases e. g. *Heptanchus*, the greater extent of the lateral canal is represented by a furrow; while in other cases, e. g. *Alopias*, the canal system is more elaborate than in *Laemargus*, the lateral and other canals giving off numerous long branching tubules; and that while in the comparatively inactive Torpedoes the canal system is feebly developed — the ventral canals being either absent or in a vestigial condition, — in the active Myliobatidae it reaches an enormous development, partly by the folding of the canals, but chiefly by the dichotomous division of both the dorsal and ventral tubules.

3. The lateral sense organs of Elasmobranchs. II. The sensory canals of the common Skate, *Raia batis*.

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In this paper it is pointed out that the lateral sense organs of the Skate consist of 1) Sensory Canals, 2) Ampullary Canals, and 3) Sensory Follicles.

The sensory canals, the only structures dealt with in detail, have the same general arrangements and are related to the same nerves as in *Laemargus*; the supra-orbital, infra-orbital and hyo-mandibular canals being related to the superficial ophthalmic, buccal and hyo-mandibular divisions of the facial respectively, and the lateral canal to the lateralis division of the vagus. But while the canals of *Raia*

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