Anatomy. — *A cutaneous branch of the facial nerve in a teleost.* By Dr. C. J. VAN DER HORST. (Central Institute of Brain Research. Amsterdam.) (Communicated by Dr. C. U. ARIËNS KAPPERS.)

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The branchial nerves of lower vertebrates are built up from several components viz., motor fibers, gustatory fibers, fibers for the general sensibility of the mucous membrane in mouth and throat, and fibers for the general sensibility of the skin (HERRICK, JOHNSTON).

Concerning different nerves (e.g. facial, vagus, etc.), the contribution of the different sensory components is very variable. Thus the trigeminus consists for the greater part of fibers for general sensibility of the skin, a smaller part finds its endings in the epithelium of the mouth cavity, whereas gustatory fibers are absent.

In this point the trigeminus differs considerably from the three following branchial nerves: facialis, glossopharyngeus and vagus. These three nerves consist for the greater part of gustatory fibers and fibers of general sensibility to the mucous membrane, whereas only very few fibers, or none at all, have free endings in the skin of the head.

As far as is known a cutaneous branch of the vagus is always present, though it is sometimes so small that it is hardly visible. In some cases (*Prionotus* after HERRICK) this vagus branch is very large.

Cutaneous fibers seem only seldom to be present in the glossopharyngeus. EWART found them in selachians, HOUSER mentions them in *Mustelus canis*. On the other hand NORRIS and HUGHES did not find them in *Acanthias*. According to COLE cutaneous fibers of the glossopharyngeus occur in *Chimaera* and according to JOHNSTON in *Petromyzon* and *Acipenser*.

More often than in the glossopharyngeus, cutaneous fibers are present in the facial nerve. According to JOHNSTON, the ramus hyomandibularis VII of *Petromyzon dorsatus* contains a considerable number of cutaneous fibers that join centrally the spinal trigeminus tract. Whereas the cutaneous branches of the glossopharyngeus and vagus have their endings on both the dorsal and ventral aspects of the head, those of the facialis in *Petromyzon* are limited to the ventral side.

KAPPERS was able to demonstrate a cutaneous branch of the facialis, at least the central part of it, in *Heptanchus* and *Hexanchus*. Compared with the spinal fifth, the descending facialis in these sharks is only a very small bundle, which soon after its entrance, joins the trigeminus. In *Chlamydoselache* MERRIT HAWKES also found some small branches of the facialis going to the skin of the ventro-lateral side of the head. On the other hand cutaneous fibers are wanting in *Acanthias*, according to NORRIS and HUGHES, in the roots as well as in the peripheral branches of the facialis.

In *Chondrostei* NORRIS found no trace of a somatosensory element in the facialis roots. ALLIS described a cutaneous branch in *Polyodon*, but NORRIS is of the opinion that it is a lateralis branch. And yet the truncus hyomandibularis receives cutaneous fibers, but by way of an anastomosis with the vagus. This connection has already been found before by STANNIUS in *Acipenser*. ALLIS showed its presence in *Polyodon*. NORRIS could state its somato-sensory character without doubt in *Polyodon* and *Acipenser*. In *Scaphirhynchus* this was less clear.

In Amphibians a connection exists between the vagus and the facialis in the same way. In *Siren lacertina*, however, this anastomosis is very thin (DRÜNER); sometimes it may be wanting altogether. NORRIS was able to show that in this animal, near the exit of the motor facialis, cutaneous fibers split off from the very superficially located spinal trigeminus and go out with the facialis. The ganglion of these cutaneous fibers is situated at the ventral side of the motor facialis. RÖTHIG also demonstrated such a cutaneous branch belonging to the facialis in *Megalobatrachus* and *Bufo*.

In teleosts the truncus hyomandibularis contains cutaneous fibers, as was demonstrated by RUTKIEWICZ in *Ameiurus* and by HERRICK in *Ameiurus*, *Menidia* and *Gadus*, but these cutaneous fibers unite only peripherally with the facialis. They leave the brain with the spinal trigeminus and their cellbodies form a part of the ganglion Gasseri. A real cutaneous branch of the facialis has not been shown in teleosts before the present finding.

Somato-sensory fibers were found by KINGSBURY in *Amia*; this was confirmed by NORRIS. The latter author could point out the presence of these fibers in even a greater number in *Lepidosteus*. This somato-sensory bundle consists almost entirely of fibers without myelin sheath. They split off from the spinal trigeminus which runs quite near the outer surface of the oblongata and their ganglion is situated at the caudal and ventral side of the whole complex of the trigeminus and facialis ganglia. The fibers run in the truncus hyomandibularis to the periphery.

As mentioned above a cutaneous branch of the facialis has not been found in teleosts before, but in *Albula* such a branch is present. Although the fibers are unmyelinated for the greater part, they form such an apparent and well defined bundle that it is the most striking one in the medulla oblongata, especially in the region of the vagus, and this bundle of the descending facialis can be traced from its entrance to its central ending without any difficulty.

In the intracerebral path, the cutaneous branch of the facialis in *Albula* differs considerably from the cutaneous branches of the other above mentioned animals. In the latter the somato-sensory facialis joins the descending trigeminus directly after its entrance. In *Amia* and *Lepidosteus* the trigeminus bundle runs near the very surface of the oblongata, according to NORRIS, and the same holds true in *Siren lacertina*. But in *Albula*, as in all other teleosts, the descending trigeminus is situated deeper in the oblongata at the dorsal side of the secundary gustatory tract.

In selachians, the trigeminus bundle has the same position and thus the cutaneous branch of the facialis of *Hexanchus* and *Heptanchus* penetrates deeply in the oblongata to join the trigeminus, as was shown by KAPPERS. On the other hand, in *Albula* the descending facialis remains near the periphery and a union with the trigeminus does not occur. Only near the end nucleus behind the calamus scriptorius does the trigeminus approach the surface and the bundles run alongside each other.

The cutaneous branches of the vagus, which are very apparent in *Albula*, no longer unite with the descending trigeminus in this teleost, though in others they do. In *Albula* these branches unite with the descending facialis. A cutaneous branch of the glossopharyngeus is not present.

From its entrance into the oblongata, the spinal facialis runs caudad in the ventral part of the lateralis nucleus near the outer surface. With the diminishing size of the lobus liniae lateralis, the descending facialis approaches the dorsal side of the oblongata more and more. In the vagus-region the spinal trigeminus also comes near the surface. These two descending bundles are separated here by the entering sensory vagus roots.

The cutaneous fibers of the vagus join the facialis directly at its ventral side. A little behind the calamus scriptorius after the entrance of the last sensory vagus roots, the descending trigeminus takes a position at the medial side of the facialis and vagus bundles.

Whereas the visceral commissural nucleus is rather small, the somatic one is large. At its lateral side and hence caudad, this somatic commissural nucleus forms one mass with the endnucleus of the descending trigeminus, facialis and vagus bundles and further on with the somato-sensory area of the spinal cord. Around this nucleus, the three descending bundles are arranged in such a way that the facialis is at its dorsal, the vagus at its lateral and the trigeminus at its ventral side. So the fibers penetrate the nucleus from all sides (fig. 1).

The dorsal spinal roots split up in two parts at their entrance. Of the first root smaller numbers of fibers curve dorsad and, running near the surface, join the vagus and the facialis. Greater numbers of fibers enter horizontally and join the trigeminus. Of the second spinal root, most of the fibers bend dorsad at their entrance.

Frontally, about at the level of the first dorsal spinal root, the somato-sensory nucleus is so large that it occupies nearly half the spinal cord (fig. 1). At the level of the second root, where nearly all facialis and vagus fibers seem to have disappeared, the nucleus is considerably smaller. And yet still further caudad the somato-sensory area remains very large in comparison with other teleosts. Here the nucleus exhibits the peculiarity that it does not form a more or less compact mass as is usually the case in teleosts, but has the shape of a rather thin curved lamella (fig. 2). Thus it assumes a form similar to the lower olive and other, especially sensory, areas that enlarge their surface by making folds. These lamellations not situated at the outer surface of the central nervous system are called by KAPPERS „inner cortical structures".

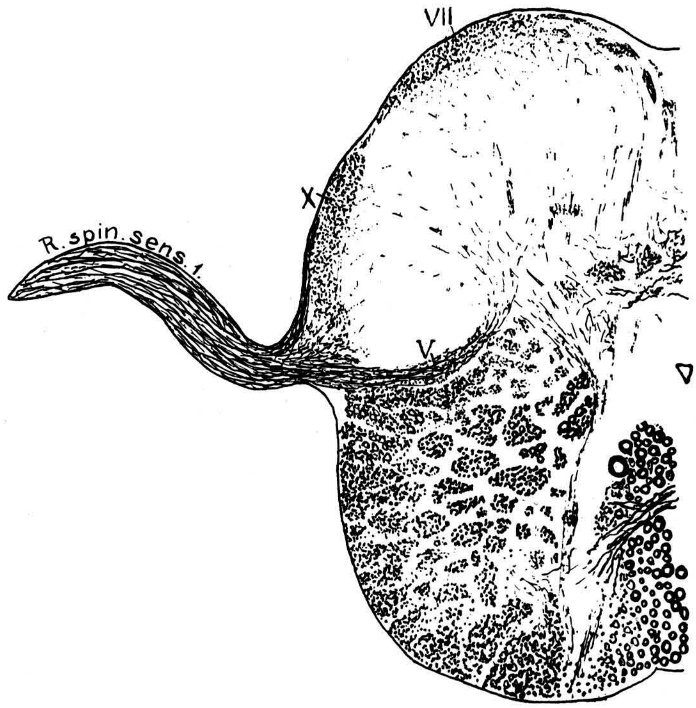

Fig. 1. Transverse section of the spinal cord of *Albula vulpes* at the level of the first sensory spinal root.

At its entrance into the medulla oblongata, the cutaneous branch of the facialis is situated rather at a distance from the gustatory branch (fig. 3). The latter runs more dorsally at the fronto-medial side of the nerveus lateralis anterior. Ventral to the lateralis is the entrance of the nervus octavus and here the fibers of this nerve surround the cutaneous branch of the facial from all sides. At its entrance, frontal to the nervus octavus, the descending facialis is in close relation with the motor seventh. The fibers of the latter surround those of the former almost entirely. According to NORRIS, in *Amia* and *Lepidosteus* also, the cutaneous branch of the facialis enters the oblongata in close proximity to the motor part and in *Siren* the motor root surrounds the cutaneous branch much in the same way as in *Albula*.

Somewhat nearer the periphery, these two facialis roots join the nervus lateralis anterior at its ventral side. The lightly coloured fibers of the cutaneous branch are separated from the lateralis by the heavily myelinated and thus, by the WEIGERT-method, darkly coloured motor fibers.

To this complex, the gustatory bundle of the facialis is added and, more frontally, also the trigeminus. The ganglion of the cutaneous root of the

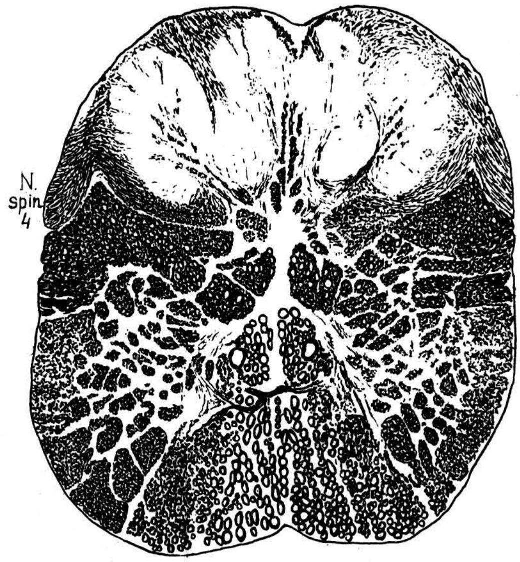

Fig. 2. Transverse section of the spinal cord of *Albula vulpes* at the level of the fourth spinal nerve.

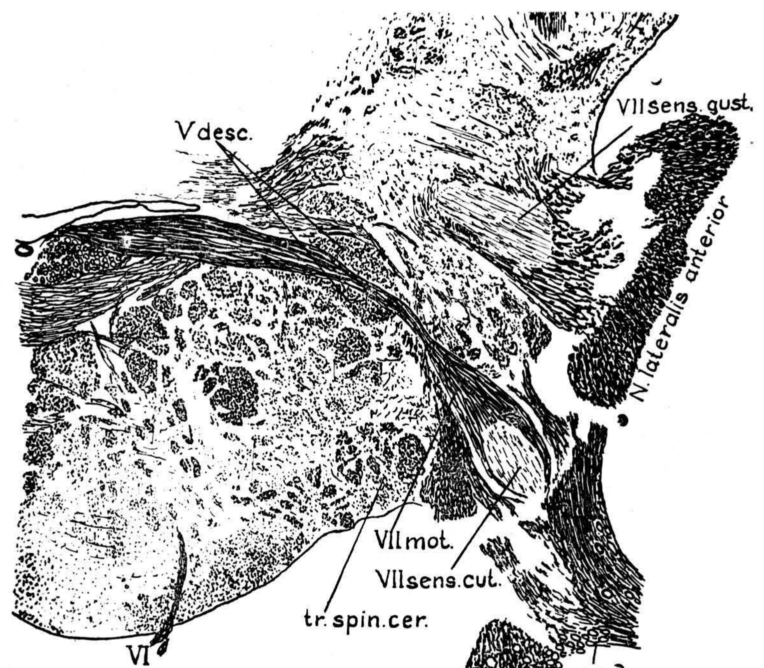

Fig. 3. Transverse section of a part of the medulla oblongata of *Albula vulpes* near the entrance of the N. facialis.

facialis is situated wholly within the skull cavity in contrast to the other ganglia of this complex. The cellbodies are much smaller than those of the lateralis. The cutaneous branch of the facialis goes to the periphery in the truncus hyomandibularis, as is always the case if such a branch is present.

I have studied various other teleosts in search of a cutaneous branch of the facialis. Nowhere have I found it. In *Megalops*, like *Albula* a very primitive teleost, it certainly is absent. But it is possible that a cutaneous facialis is present in the *Mormyridae*. The tractus spino-cerebellaris dorsalis that is highly developed in this family of fishes runs quite near the surface, as is also shown in the figures of STENDELL. So this tract in *Mormyridae* does not follow the ordinary way in close contact with the descending trigeminus, but runs nearer the surface and in the position where a descending facialis could be expected. It is possible that this tract contains facial fibers ; my material, however, was not sufficient to decide this and neither do the figures of STENDELL. In *Gadus* and notably in *Lota*, a cutaneous facialis is absent, though the sensibility of the skin of the head is highly developed in these fishes, and in relation with this, the cutaneous branches of the trigeminus and vagus are very large. Also in other teleosts the truncus hyomandibularis contains fibers for general sensibility of the skin that arise from the ganglion Gasseri, according to HERRICK, and so are trigeminus fibers that only join the truncus peripherally. It is possible that the cutaneous fibers going out in *Albula*, *Amia* and *Lepidosteus* with the motor facialis, leave the central nervous system in other fishes farther frontally, together with the cutaneous fibers of the trigeminus.

No doubt the sensibility of the skin of the head is highly developed in *Albula*, as has already been indicated by the extension of the somatosensory area in the frontal part of the spinal cord. This extension is not caused by a hypertrophy of the dorsal spinal roots as in *Trigla* and *Prionotus* ; on the contrary these roots are rather small in *Albula*. And yet the descending trigeminus is not especially large in *Albula* ; in *Gadidae* it is much larger.

This makes it apparent that the same cutaneous fibers that enter with the trigeminus in nearly all teleosts, reach the central nervous system in *Albula*, *Amia* and *Lepidosteus* with the motor facialis. This shows some similarity with the phenomenon in motor roots that ADDENS calls "central anastomosis". The peculiarity of *Albula*, in contradistinction to *Amia* and *Lepidosteus*, is that the descending facialis does not join the spinal trigeminus, but remains as a well defined, separate bundle along its whole course.

According to GILL, *Albula* is met with especially near the coast, where it looks for its foods in the shallow water. The food consists of molluscs, especially lamellibranchiates, that live in the mud or sand and therefore are probably found by feeling. When the fish is looking for its food in the shallow water it has the head downwards and puts the tail out of the water. This habit may give an explanation for the highly developed sensibility of the head in *Albula*.

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