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H. W. Norris

Margaret Buckley

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THE PERIPHERAL DISTRIBUTION OF THE CRANIAL NERVES OF NECTURUS MACULATUS.

BY H. W. NORRIS AND MARGARET BUCKLEY.

Although Necturus is so commonly used in laboratory courses of vertebrate dissection there have been few attempts made to give a systematic account of its cranial nerves. Laboratory guides and outlines still adhere to an antiquated nomenclature in reference to the nervous system of Necturus, for which procedure there is little excuse in the light of the work that has been done already on the nervous systems of other Urodela.

The oldest account we have of the cranial nerves of Necturus seems to be that of Fischer (1864). From the figures which he gives it is evident that there has been little added to our knowledge of the general topography of the fifth, seventh, ninth and tenth nerves since his contributions were made. The origins of the cranial nerves were described with great care and accuracy by Kingsbury (1895) in his paper on the brain of Necturus. Druner (1902) has given a very thorough description of the seventh, ninth, tenth and hypoglossal nerves in their relation to the branchial arches and the connected musculature. The development of the peripheral nervous system in Necturus, particularly of the lateral line system, has been made known through the observations of Miss Platt (1896). To the present time there has appeared no systematic account of the nerve components in Necturus. To supply this information this paper is a preliminary attempt.

The descriptions in this paper are based largely upon studies made with serial sections of larvae of 35 mm. in length. The material was fixed in vom Rath's pico-aceto-platino-osmic mixture, and sectioned in the three conventional planes. Plottings of the cranial and first and second spinal nerves were made upon the sagittal plane, enlarged about 250 times.

In general it may be said that the cranial nerves of Necturus do not indicate a primitive or ancestral condition. Rather they conform very closely to the arrangement in the Salamandridae as it has been described in Amblystoma (Coghill, 1902) and Spelerpes (Bowers, 1900).

In fact, the resemblances to the condition in the latter form are very close and suggestive.

Kingsbury (1895) describes the olfactory nerve of the adult Necturus as arising "from the ventro-lateral angle of the olfactory lobes as a single root." By the study of horizontal sections the writers have found that the olfactory glomeruli show an evident arrangement in two groups; a posterior dorsal and an anterior ventral group. Corresponding there are two groups of fibers or roots, which very soon combine to form the long olfactory nerve. From the interweaving of the fibers it is impossible to correlate the distribution of the divisions of the olfactory nerve with their origin from the brain. In a larval Necturus of 35 mm. length the olfactory capsule lies lateral and but little anterior to the olfactory lobe, and in consequence the olfactory nerve is short. It passes through the cranial wall by three apertures, one dorsal and posterior and the other two more ventral and anterior. The fibers that pass through the posterior opening supply chiefly the posterior dorsal and lateral olfactory epithelium, some branches also passing along the median nasal wall well toward the anterior portion. The nerves passing through the anterior openings supply the anterior part of the olfactory epithelium. The arrangement of the glomeruli into anterior and posterior groups is not as evident as in the adult. The arrangement of the glomeruli in the adult is strongly suggestive of the condition described by Lee (1893) in Spelerpes fuscus and Salamandrina perspicillata, where he finds two distinct groups of glomeruli with two olfactory roots. In Spelerpes bilineatus the writers have found the two-fold grouping of the glomeruli even more evident than in Necturus, and as in the latter more distinct in the adult thon in the larva. It is evident that the contention of Lee that this double nature of the olfactory nerve in many, if not all, Amphibia has nothing to do with the innervation of Jacobson's organ, is well founded for in Necturus the latter organ is absent.

No account is here given of the optic and the eye-muscle nerves in Necturus. Their poorly developed condition has rendered the study of the eye-muscle nerves difficult, and a report on them is deferred to a later time.

The trigeminal nerve has few characteristics worthy of especial mention. Its general cutaneous elements are distributed to four nerves: (1) the ramus mandibularis, (2) the ramus ophthalmicus profundus, (3) the so-called ramus maxillaris that joins the r. buccalis VII, (4) a small component that passes into the r. ophthalmicus superficialis VII. A small branch of the r. mandibularis enters a canal in the lower jaw and comes into intimate relation with a branch of the r. alveolaris VII, although no actual anatomosing was demonstrated. An anastomosis between these two branches occurs in Amblystoma (Coghill, l. c.), Amphiuma (Norris, 1908), Plethodon (Norris, 1909), and Spelerpes, although Miss Bowers failed to find it in the latter. The r. oph. prof. after giving off a dorsal branch at the median border of the posterior part of the eyeball divides into the three terminal branches that seem characteristic of the Urodela. The ophthalmic-palatine anastomosis appears to resemble that described by Coghill (1906) in Triton, but its exact nature could not be determined in the material available for study. In the dorsal branch of the r. oph. prof. referred to above the trochlear nerve seems to pass to its innervation of the superior oblique muscle, but where it enters the ophthalmic branch was not determined. This relation seems to be almost identical with that in Spelerpes. The infra-orbital trunk formed by the union of the r. maxillaris V and the r. buccalis VII is similar to the corresponding trunk in Amblystoma and Spelerpes. General cutaneous fibers entering the r. oph. spf. VII have been reported in Amphiuma (Norris, 1908), Siren (Norris, 1910, 1911). In young adults of Plethodon glutinosus shortly after the metamorphosis and loss of the lateral line system a small general cutaneous nerve can be found passing antero-dorsally out of the gasserian ganglion along a course that must have been occupied by the r. oph. spf. VII of the larval stage (Norris, 1909). Coghill does not report such fibers in Amblystoma nor does Miss Bowers distinguish them in Spelerpes.

The facial nerve shows the six characteristic rami: (1) ramus ophthalmicus superficialis, (2) ramus buccalis, (3) ramus mentalis, (4) ramus alveolaris, (5) ramus palatinus, and (6) ramus jugularis. The first three have the characteristic distribution to the neuromasts of the head. The ventral lateral line ganglion is almost wholly outside the skull and sharply distinguishable from both the auditory ganglion, and the gasserian ganglion. The ramus communicans from the IX-X nerves contains both general cutaneous and communis components. It sends its general cutaneous fibers into the r. jugularis and its communis fibers into the r. alveolaris, resembling in this respect the ramus communicans in Amblystoma and Spelerpes. Miss Bowers, however, recognized only general cutaneous fibers in the r. communicans. As noted by previous writers the r. jugularis passes dorsal to the squamoso-columellar ligament. A truncus hyomandibularis can hardly be said to exist in Necturus as the motor components of the facial nerve take their departure at the exit of the main nerve from the skull. As to the existence of a distinct Jacobson's commissure the evidence is not convincing. It is certain that pharyngeal branches of the ninth nerve come into close proximity with the posterior part of, or branches of, the r. palatinus; apparently there is an anastomosing of branches.

The glossopharyngeal—vagus complex in Necturus gives little evidence of being in a primitive condition. The three branchial nerves involved have been described by both Fischer (l. c.) and Druner (l. c.) with an accuracy that needs little comment. The glossopharyngeal or first branchial nerve shows characteristic pharyngeal, pretrematic and posttrematic rami. It also sends a general cutaneous and motor branch that anastomoses with the second branchial nerve. The second branchial nerve (vagus 1) has well developed pharyngeal, pretrematic and posttrematic rami. One motor and general cutaneous branch supplying the levator and depressor muscles of the first gill and the overlying skin receives the above-mentioned anastomosis from the ninth nerve; other branches supply the levator and depressor muscles of the second gill; an anastomosis occurs with the third branchial nerve forming the innervation of the levator and depressor muscles of the third gill. The third branchial nerve (vagus 2) is very much reduced. In it, however, may be recognized pretrematic and posttrematic rami of communis fibers only, while the main part of the nerve forms an anastomosis with a branch of the second branchial nerve as previously mentioned. These anastomoses between the branchial nerves in Necturus are seen to be homologous to similar structures in Amblystoma. They also occur in Spelerpes, but were overlooked by Miss Bowers. They are not found in Siren. The ramus communicans from the IX-X to the VII nerve contains in addition to the general cutaneous fibers a small communis component, the distribution of which has been described. The r. supra-temporalis arises from the ganglion along with the motor nerve for the levator muscle of the first branchial arch, in the manner described by Druner. The r. auricularis X has the usual origin and distribution, being composed of general cutaneous and lateral line fibers. The rami laterales dorsalis et medius are as in other Urodela. The ramus intestino-accessorius X divides into three typical branches: r. lateralis ventralis, r. intestinalis recurrens, and r. intestinalis. There seem to be unusual features in their distribution.

Fischer states that the hypoglossal nerve in Necturus is formed from branches of the second and third spinal nerves. Druner affirms that it is the first and second spinal nerves that contribute to its formation. The statement of Druner is confirmed, but the writers find that a small branch of the third spinal nerves seems to unite with the trunk formed by the union of branches from the first and second. In Necturus the two anterior spinal nerves lack ganglia.

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