

## Cranial Nerves of the Common Catfish, *Clarias batrachus* (LINN.)

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Literature on the cranial nerves of fishes is by no means adequate and the important references available on them are of WRIGHT (1884), EWART (1889), HERRICK (1898-1901), COLE (1898), ALLIS (1897-1903), BROOKOVER & JACKSON (1911), KUNTZ (1914), BERKELBACK & SPRENEL (1915), LANDACRE (1916), NORRIS & HUGHES (1920), ATODA (1936), YOUNG (1939), RAY (1959), KARANDIKAR & THAKUR (1951), MITTEL (1964), SINHA (1964) and MAHESHWARI (1965).

The common catfish is widely distributed in fresh waters of India and remains alive outside water for long time owing to the presence of accessory respiratory organs.

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### Material and Technique

Specimens of *Clarias* were procured from the fish markets of Meerut and round about places. They were preserved in 8% formalin solution after exposing their brains and bases of nerves. When the nerves were hardened, the dissections were attempted along the dorsal, ventral and lateral aspects to display the various cranial nerves with their branches. Dissections were also done to trace the nerve supply of the eye muscles and accessory respiratory organs. For observing the origin of various nerves, the brains were removed carefully with their roots intact and studied under binocular microscope.

### Observations

The ten pairs of cranial nerves are identically disposed on the two sides of the head and anterior part of body. The *nervus olfactorius* (olf. n.) arises as a pair of strands from the anterior end of the olfactory bulb. The strands run along the sides of the olfactory rosette innervating its schneiderian folds. The strands are small and slender as the bulb lies immediately behind the rosette.

The *nervus opticus* (op. n.) originates from anterior end of the optic thalamus of diencephalon. The two nerves cross one another on the ventral side of cerebrum

to form the optic chiasma. During the formation of optic chiasma, the left nerve remains dorsal to the right in most of the cases. From the cranium the nerve comes out through a space present between the parasphenoid and pleurosphenoid. Enclosed in the optic pedicel, it runs in the orbit below the supraorbital trunk and above the rami maxillaris and buccalis before entering the eye ball to innervate the retina.

The *nervus oculomotorius* (oculo.) arises from the ventral side of mid brain concealed by the inferior lobe. It comes out into the orbit through the fenestra of trigeminofacial complex. Before reaching the eye muscles, the nerve divides into two branches, a superior and an inferior branch. The superior branch after a short course innervates the superior rectus muscle of the eye. The inferior branch before passing between the superior and inferior recti muscles gives off a twig, which after running below the inferior and anterior recti muscles terminates into the inferior oblique muscle. The inferior branch then bifurcates into two branchlets, one innervating the inferior rectus muscle and the other anterior rectus muscle after passing between the superior and inferior recti muscles.

The *nervus trochlearis* (troch.) originates from the dorso-lateral aspect of brain between the optic lobe and cerebellum. It emerges out in the orbit through the fenestra of trigeminofacial complex. The nerve passes dorsal to the other eye muscle nerves and terminates in the superior oblique muscle of the eye.

The *nervus abducens* (abd.) arises from ventral surface of the anterior part of medulla oblongata. It runs first below the acoustic tubercle and inferior lobe and then under the *nervus oculomotorius* supplying the posterior rectus muscle of eye.

The *nervi trigeminalis* and *facialis* take their origin separately from the lateral side of medulla oblongata one behind the other. They soon fuse with one another to form a single massive, the *trigeminofacial complex* (tfc.) which splits into the supraorbital and infraorbital trunks after emerging out of the cranium through the fenestra bounded by the pleurosphenoid, parasphenoid and prootic. The hyomandibular trunk separates from the trigeminofacial complex before the emergence of the complex from the cranium and formation of the supraorbital and infraorbital trunks.

The *supraorbital trunk* (s. o. t.) arises as the dorsal most branch of trigeminofacial complex and runs as such for about three fourth of its length. Beyond the eye ball and on the side of orbitosphenoid, it splits into an inner thin *ramus ophthalmicus superficialis facialis* and an outer stout *ramus ophthalmicus superficialis trigeminus*, which run nearly parallel to each other for half of their proximal course. Later on the *ramus ophthalmicus superficialis facialis* (s. oph. f.) moves inward and forward innervating the skin of snout, while the *ramus ophthalmicus superficialis trigeminus* (s. oph. tr.) enters the nasal barbel. The *ramus ophthalmicus superficialis facialis* supplies the sense organs of supraorbital canal of lateral-line system throughout its course.

The *infraorbital trunk* (i. o. t.) lies below and lateral to the supraorbital trunk.

In the orbit, it separates into the *ramus buccalis* and *maxillo-mandibularis* trunk. After giving off the *ramus maxillaris* in the form of a thin branch from the dorsal side, the *maxillo-mandibular* trunk continues as *ramus mandibularis trigeminus*.

The *ramus buccalis* (r. bucc.) is very well developed and runs forward and slightly outward in the direction of maxillary barbel. In the middle of its course, the trunk gives off a branch which soon forks into the inner and outer branchlets. These branchlets run in a superficial course parallel and dorsal to the main trunk and supply the upper lip, premaxillary teeth and maxillary barbel. Immediately after the separation of dorsal branch, the *ramus buccalis* splits into two equally thick branches, which enter the maxillary barbel supplying its sense organs. Throughout the course, it supplies the infraorbital canal of lateral-line system. From the ventral surface of trigeminofacial complex and behind the origin of *ramus buccalis* arises a thin *ramus palatinus anterior* (r. pl. a.) which runs on the roof of buccal cavity supplying its mucosa.

The *ramus maxillaris* (r. max.) is associated with *ramus mandibularis* during its early course, but later separates and runs forward along the outer side of *ramus buccalis* supplying the maxillary barbel. During the middle of its course and beyond the orbit, it anastomoses with *ramus buccalis* through an equally stout and obliquely placed branch.

The *ramus mandibularis trigeminis* (r. mand. tr.) is a thick branch, which runs along the posterior and ventral borders of the orbit. Before the eye ball, it separates into an inner thin branch and an outer thick branch. The inner branch runs forward and supplies the lower lip and mandibular teeth. The outer branch again bifurcates before the angle of mouth into equally thick branchlets, the *ramus mandibularis externus* and *ramus mandibularis internus*. The *ramus mandibularis externus* (r. mand. ext.) immediately supplies the mandibular barbel, while the *ramus mandibularis internus* (r. mand. int.) innervates the dentary of lower jaw and continuous into the mental barbel. The *hyomandibular trunk* (h. md. t.) comes out of the cranium through the foramen in the hyomandibula. It runs outward and downward over the bone and separates into the *ramus hyoideus* and *ramus mandibularis facialis*. Just after its origin, the *hyomandibular trunk* gives off posteriorly a small branch, the *ramus opercularis* (r. op.) which after running downwards innervates the operculum. Beyond the origin of *ramus opercularis* a slender nerve, the *ramus palatinus posterior* (r. pl. p.) arises from its anterior surface, which runs forward below all the nerves of the orbital region. It remains parallel and lateral to the *ramus palatinus anterior* and supplies the roof of the buccal cavity.

The *ramus hyoideus* (r. hyo.) enters in the groove present between the hyomandibula and the preoperculum. It passes to the branchiostegal membrane supplying the basal region of branchiostegal rays.

The *ramus mandibularis facialis* (r. mand. f.) courses over the hyomandibula and

quadrate and gives off a slender branch terminating into the lower jaw. It runs forward in a groove on the inner side of the angular and dentary supplying the mandibular canal of lateral-line system.

From the dorsal surface of trigeminofacial complex arises the *ramus lateralis accessorius* (r. lat. a.) which first runs over the acoustic tubercle and then pierces the supraoccipital bone to move behind on the side of the occipital crest and neural spines of vertebrae. During its course, it receives the dorsal rami of spinal nerves.

The *nervus acousticus* (aud. n.) arises from the latero-ventral surface of medulla behind the origin of *nervus facialis*. It is broad at its base and just after the origin splits into an anterior vestibular and a posterior saccular branch. The vestibular branch runs directly downward and terminates in a number of branchlets arranged in a fan-like fashion, which supply the utricle and ampullae of semicircular canals of the membranous labyrinth. The saccular branch extends straight behind and on reaching the saccular portion splits into two branchlets, one supplying the sacculus and lagena and the other innervating the sinus endolymphaticus.

The *nervus glossopharyngeus* (gloss.) takes its origin by a single root from the ventro-lateral side of the medulla behind the origin of *nervus acousticus*. The trunk runs behind and outward to emerge from the cranium through a foramen in the exoccipital. It runs along the anterior border of first gill arch supplying its anterior gill lamellae.

The *nervus vagi* (vg. n.) is very well developed and originates by double root from the ventro-lateral side of medulla immediately behind the origin of *nervus glossopharyngeus*. Both roots unite soon and form the vagal mass, which emerges out of the cranium through the vagus foramen in the exoccipital and splits immediately into four branches. Of these the first two form the first and second branchiales, the third gets divided into the third and fourth branchiales and the fourth forms the visceralis. Each branchialis runs parallel with the *nervus glossopharyngeus* to its branchial arch. It separates into the thin pretrematic and thick posttrematic branches. The pretrematic branch of each branchialis runs along the hind border of the gill arch supplying the posterior gill lamellae. The posttrematic branch runs along the front face of succeeding gill arch and innervates its anterior gill lamellae. The pretrematic of first branchialis separates into three branches and posttrematic of the first and second branchiales into two branches in their gill arches. The posttrematic branch of fourth branchialis runs behind the fourth gill arch and supplies the mucous membrane of branchial cavity.

From each branchialis except the first, arises a *pharyngeal branch* (ph. br.) differing in their origin from one another. It arises from the base of pretrematic in second branchialis, from the posterior border of the main trunk in third branchialis and from the very origin of the trunk in fourth branchialis.

The accessory respiratory organs of the fish are in the form of respiratory trees

borne on the dorsal side of the second and fourth gill arches. The respiratory tree of the second gill arch is supplied through a branch from the pretrematic of second branchialis, while that of fourth gill arch through a branch of posttrematic of fourth branchialis.

The *ramus visceralis* (visc. br.) runs behind the fourth branchialis along the posterior border of last gill arch and divides into four branches; the two run forwards on the floor of branchial cavity and supply the pericardium and heart and the remaining two turn behind and enter the body cavity supplying the alimentary canal and liver.

The *ramus lateralis vagi* (r. lat. vg.) arises as a stout branch from the base of vagal mass before its separation into the four branches of the branchiales and visceralis. It runs downward and outward at the posterior margin of branchial cavity and divides into a dorsal stout branch and a ventral less prominent branch. The ventral branch soon gives off a thin branch for the pectoral fin and running downwards takes a course parallel to the dorsal branch. Before splitting into the dorsal and ventral branches, the lateralis gives off two slender nerves placed one behind the other from its lower side supplying the posterior border of branchial chamber.

### Discussion

The present discussion is curtailed to the analysis with the author's previous contribution on *Amphipnous cuchia* (HAM.), where a detailed discussion including bony fishes in general has already been given.

The nervus olfactorius is in the form of a pair of thin and small strands in *Clarias*, while long and stout being adherent to the other during the first half of its course in *Amphipnous*. It supplies the olfactory rosette directly in *Clarias* and through several branches formed by its splitting in the orbitonasal canal in *Amphipnous*. The nervus opticus reaches in the orbit through the foramen in between the parasphenoid and pleurosphenoid in *Clarias* and through the lateral ethmoid in *Amphipnous*. The optic chiasma lies under the cerebrum in *Claris* and under the olfactory lobes in *Amphipnous*.

The nervi oculomotorius, trochlearis and abducens emerge into the orbit through the fenestra of trigeminofacial complex in *Clarias* and through optic foramen in *Amphipnous*. The hyomandibular trunk separates from the complex in *Clarias* and from the nervus facialis before the complex formation in *Amphipnous*. A connection between hyomandibular trunk and trigeminofacial complex has been observed in *Amphipnous* only. The supraorbital trunk splits into the rami ophthalmicus superficialis trigeminus and ophthalmicus superficialis facialis beyond the eye ball in *Clarias* and before the eye ball in *Amphipnous*. The infraorbital trunk separates into the ramus buccalis and maxillomandibularis trunk in *Clarias* and into the buccalo-maxillaris trunk and ramus mandibularis in *Amphipnous*. The ramus mandibularis tri-

geminus gives off the ramus premaxillaris before the angle of mouth in *Amphipnous*, but not in *Clarias*. Anastomoses have been noted between the ramus maxillaris and ramus buccalis in *Clarias*, while also in between ramus mandibularis trigeminus and ramus mandibularis facialis in *Amphipnous*. The ramus lateralis accessorius arises by single root in *Clarias* and by a pair of roots in *Amphipnous*. It maintains connection with nervus vagi in *Amphipnous*, while no such anastomosis exists in *Clarias*. Both rami palatinus anterior and palatinus posterior occur in *Clarias*, while besides the usual ramus palatinus posterior, an accessory palatinus posterior is also present in *Amphipnous*.

The nervus acusticus in its posterior part is better developed in *Clarias*, but like the anterior part in *Amphipnous*. It maintains anastomoses with the hyomandibular trunk in front and also between its two parts in *Amphipnous*, but not in *Clarias*. The nervus glossopharyngeus arises through a single root in *Clarias* and through a pair of roots in *Amphipnous*. It shows anastomoses with hyomandibular trunk in front and with nervus vagi behind. The vagal mass of nervus vagi distinguishes into four trunks in *Clarias* and into five trunks in *Amphipnous*. There is present only single visceralis branch in *Clarias*, whereas two visceralis branches in *Amphipnous*. The pharyngeal branches arise from each branchialis except the first in *Clarias* and from only vagal mass in *Amphipnous*. The accessory respiratory organs are supplied by second and fourth branchiales in *Clarias* and by the branch for the body wall in *Amphipnous*.

### Summary

The nervus olfactorius is thin and small, since the olfactory bulb lies just behind the olfactory rosette. It supplies the olfactory rosette by a pair of branches, which arise independently. The nervus opticus enters the orbit through the optic foramen bounded by the parasphenoid and pleurosphenoid. During the decussation of optic nerves, the left nerve lies dorsal in most of the cases. The eye muscle nerves emerge from the cranium through the foramen for the trigeminofacial complex, which arises by two roots and emerges out of the cranium through the space between the parasphenoid, pleurosphenoid and prootic. It separates first the hyomandibular trunk intracranially, and splits into supraorbital and infraorbital trunks extracranially. The supraorbital trunk splits into the rami ophthalmicus superficialis facialis and ophthalmicus superficialis trigeminus beyond the eye ball. The infraorbital trunk distinguishes into the ramus buccalis and maxillo-mandibularis trunk. The ramus maxillaris supplies the maxillary barbel and the upper jaw. The ramus buccalis supplies the infraorbital canal of lateral-line system and sense organs of maxillary barbel. The ramus mandibularis trigeminus separates into the external and internal branches before the gap of the mouth and supply the mandibular and mental barbels and lower jaw. Anastomosis exists between ramus maxillaris and ramus

buccalis. The ramus lateralis accessorius extends back from the trigeminofacial complex collecting the dorsal rami of spinal nerves. Both anterior and posterior palatinus branches are present. The nerves glossopharyngeus arises through a single root and emerges through separate foramen. The vagal mass divides into the trunk of branchiales, another trunk of visceralis and the third trunk of ramus lateralis vagi. The trunk of branchiales again shows division into an anterior, which gives rise to first two branchiales and posterior, which produces the remaining branchiales. The pharyngeal branches arise from the second and third branchiales and from between the third and fourth branchiales. The respiratory trees on the second and fourth gill archs are supplied by the branches of the pretrematic of second and the posttrematic of fourth branchiales respectively.

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### Explanation of the Plates

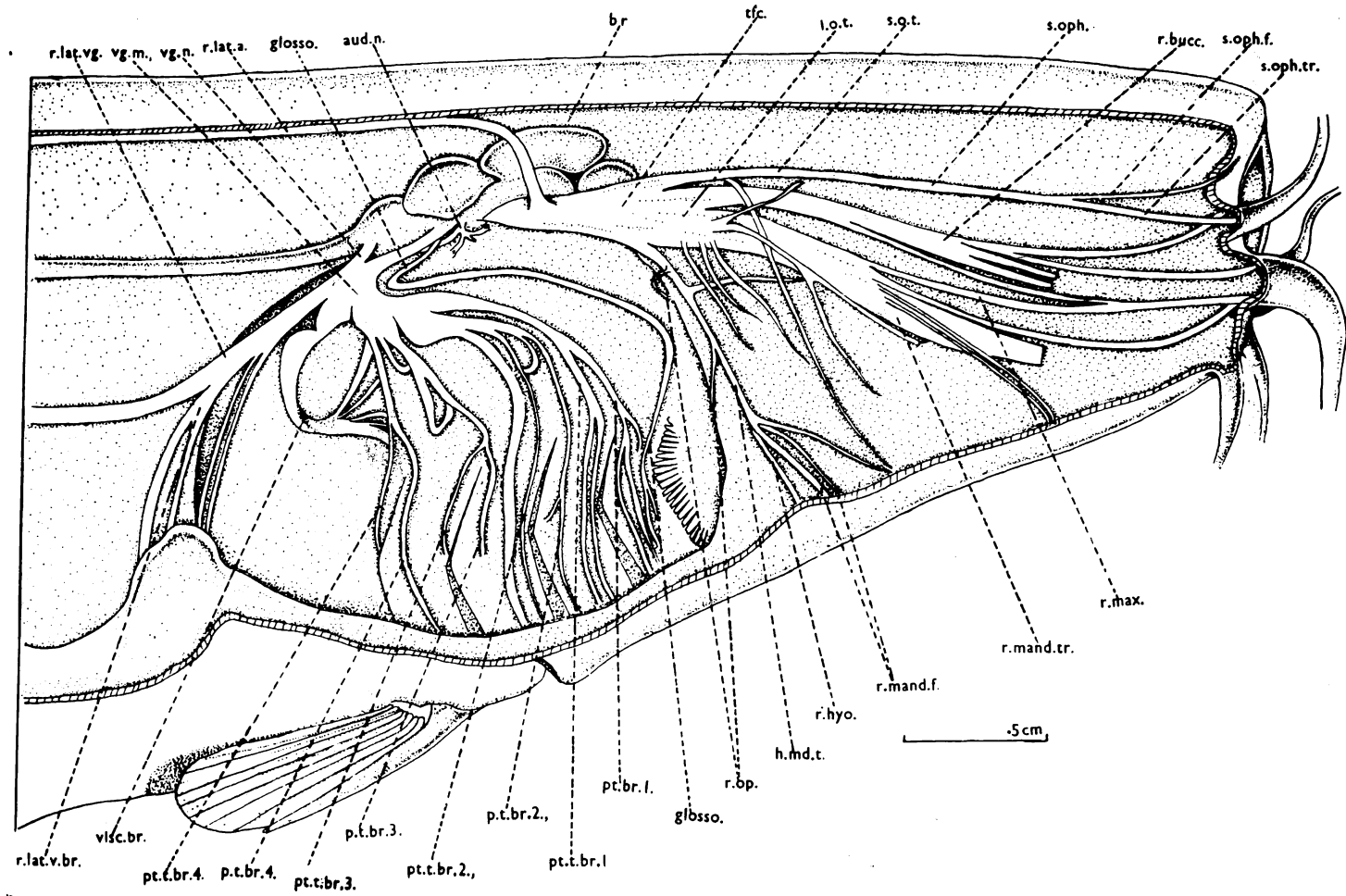
- Plate 8 Lateral view of the cranial nerves of *C. batrachus*.
- Plate 9 Lateral view of the cranial nerves of *C. batrachus*.
- Plate 10 Dorsal view of the cranial nerves of *C. batrachus*.
- Plate 11 Ventral view of the cranial nerves of *C. batrachus*.
- Plate 12 1. Cranial nerves on the ventral side in *C. batrachus*.  
2. Innervation of the eye muscles in *C. batrachus*.

### Explanations of the Abbreviations Used

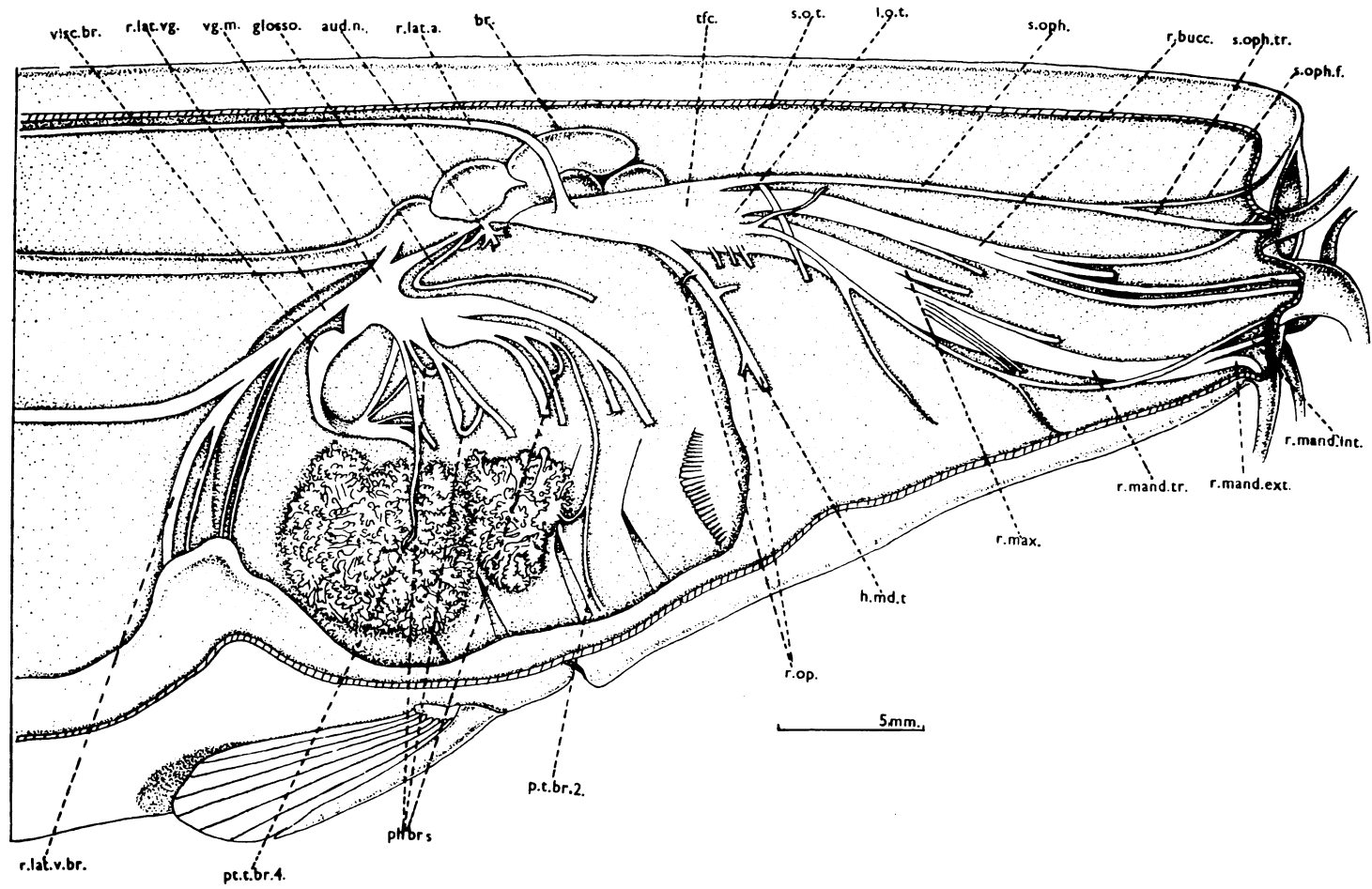
*ad.*, nervus abducens; *aud.n.*, nervus acousticus; *br.*, brain; *glosso.*, nervus glossopharyngeus; *h.md.t.*, hyomandibular trunk; *i.o.t.*, infraorbital trunk; *olf.b.*, olfactory bulb; *olf.n.*, olfactory nerve or nervus olfactorius; *olf.tr.*, olfactory tract; *op.n.*, nervus opticus; *ph.brs.*, pharyngeal branches; *ph.br.4.*, pharyngeal branch of fourth branchialis; *r.pl.a.*, ramus palatinus anterior; *r.bucc.*, ramus buccalis; *r.max.*, ramus maxillaris; *r.mand.tr.*, ramus mandibularis trigeminus; *r.mand.ext.*, ramus mandibularis externus; *r.mand.int.*, ramus mandibularis internus; *r.op.*, ramus opercularis; *r.pl.p.*, ramus palatinus posterior; *r.hyo.*, ramus hyoideus; *r.mand.f.*, ramus mandibularis facialis; *r.lat.vq.*, ramus lateralis vagi; *r.lat.v.br.*, ramus lateralis vagi ventral branch; *r.lat.a.*, ramus lateralis accessorius; *s.o.t.*, supraorbital trunk; *s.op.h.*, ramus ophthalmicus superficialis; *s.op.h.tr.*, ramus ophthalmicus superficialis trigeminus; *s.op.h.f.*, ramus ophthalmicus superficialis facialis; *troch.*, nervus trochlearis; *tfc.*, trigeminofacial complex; *visc.br.*, visceralis branch or ramus visceralis; *vg.n.*, nervus vagi; *vg.m.*, vagal mass; *p.t.br.1-4.*, pretrematic branches 1-4; *pt.t.br.1-4.*, posttrematic branches 1-4.



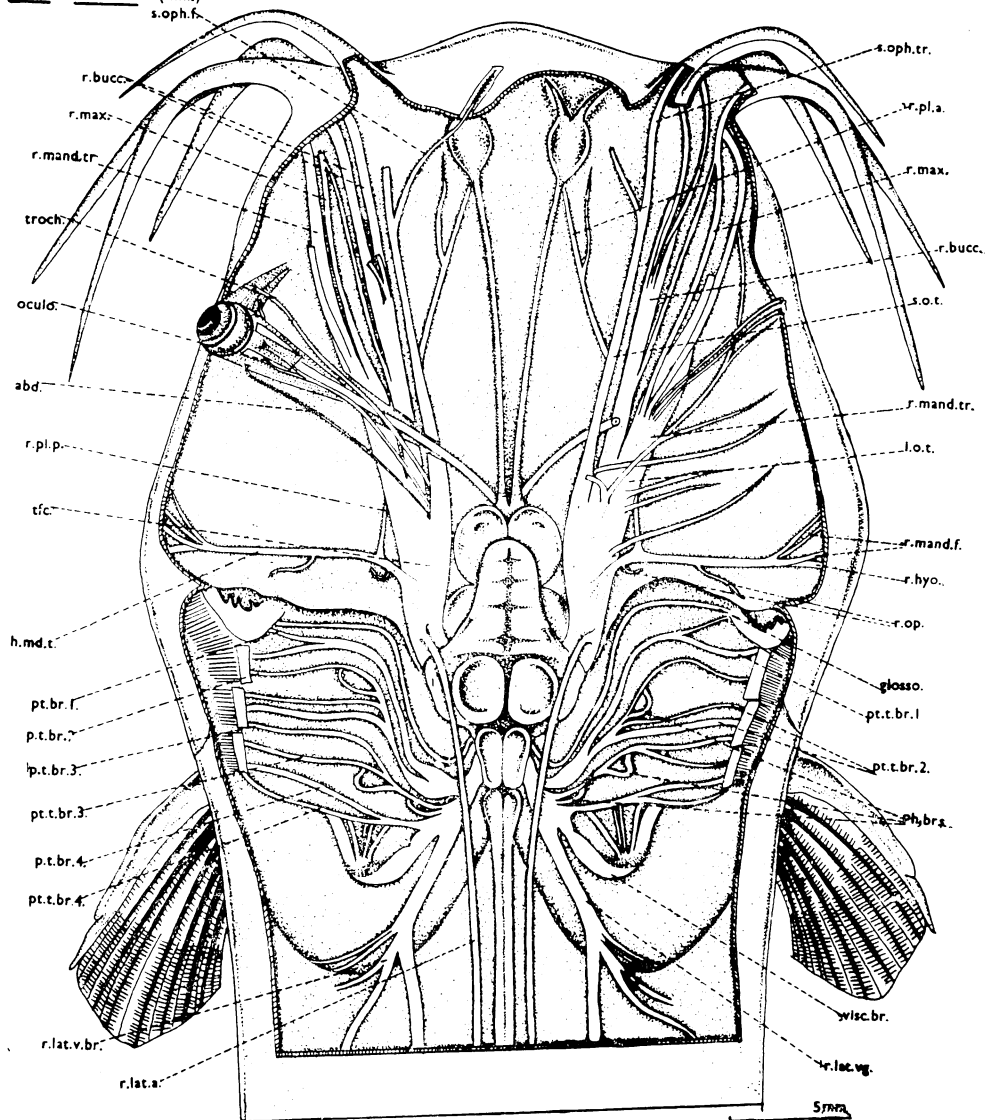
**Clarias batrachus (linn.)**



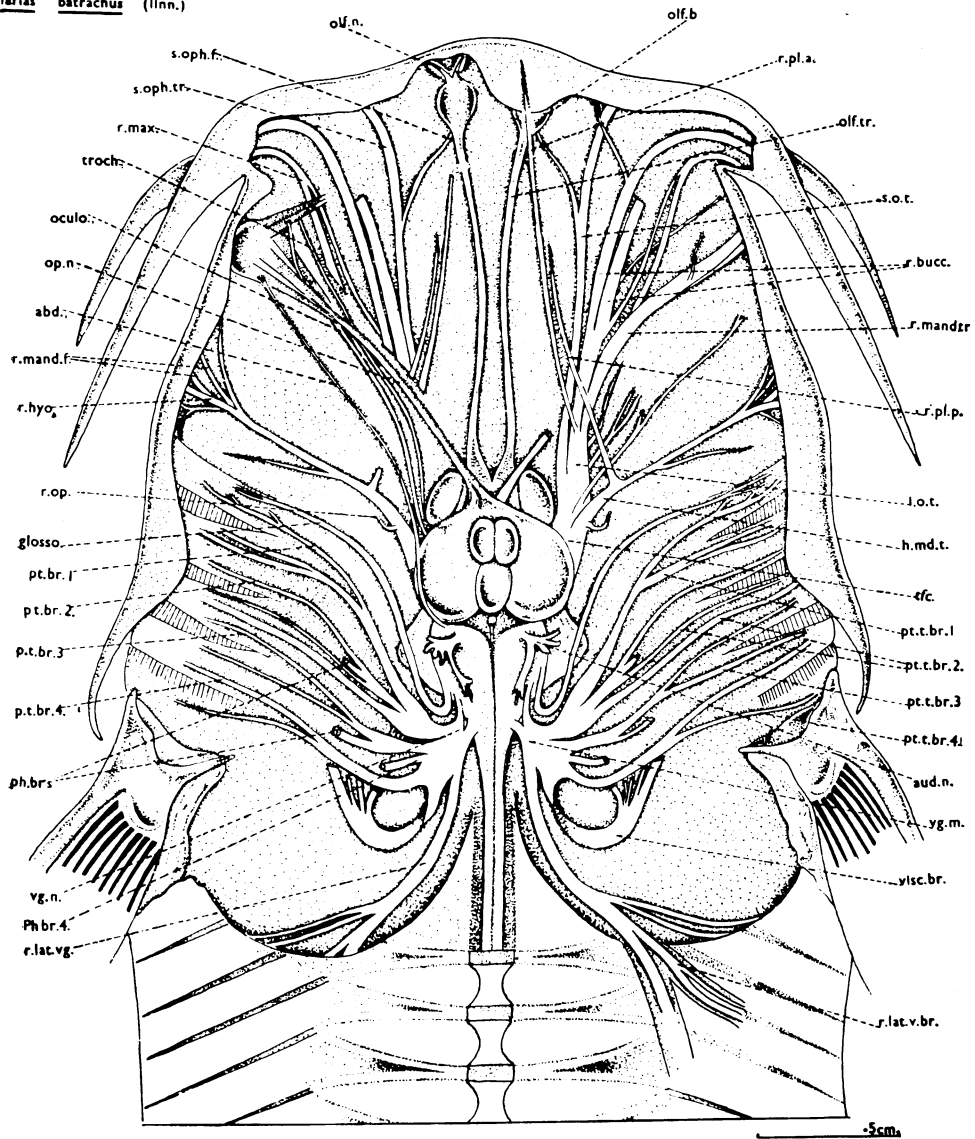
**Clarias batrachus (linn.)**



Clarias batrachus (linn.)  
s.oph.f.



Clarias batrachus (linn.)



Clarias batrachus (Hinn.)

