VI. ON THE NERVOUS SYSTEM OF *AMPULLARIA GLOBOSA*.

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The present animal is a common pond-snail of Bengal, and can be procured in any number from the ponds in the suburbs of Calcutta. Having access to an ample supply of specimens, I availed myself of the opportunity of studying the nervous system by dissecting a large number of them.

The comparative anatomy of the genus *Ampullaria* was studied by Prof. E. L. Bouvier, who published an excellent monograph [1] on the subject in connection with other Prosobranchiate Molluscs in 1887. He described the nervous system and general morphology of *Ampullaria carinata*, which differs from the present species in several interesting points. In 1910, Capt. R. E. Lloyd described the anatomical features of the present species in his *Introduction to biology for students in India* [2]. The book, being meant for the junior students of biology, dealt with the matter in a concise form, and did not enter into any detail. The present article is meant to describe the subject in some detail.

General.—The cerebral ganglia are widely separated by a ribbon-shaped inter-cerebral commissure. The cerebro-pleural and cerebro-pedal commissures are long, while the pleuro-pedal commissure is practically absent, the ganglia being closely apposed to, although distinct from, each other; this constitutes a "hypoathroid condition." The supra-intestinal nerve passes from the right pleural over the oesophagus to the supra-intestinal ganglion also connected to the pleural ganglion of the left side by a secondary commissure forming a zygoneurous type [2]. The infra-intestinal nerve passes from the left pleural ganglion to the infra-intestinal, being connected to the pleural ganglion of the other side on its way to the latter. The pedal ganglia are connected to each other by an inter-pedal commissure.

Each cerebral ganglion gives off a fine nerve connected to the buccal ganglion of the same side through the intervention of a small nerve from the latter.

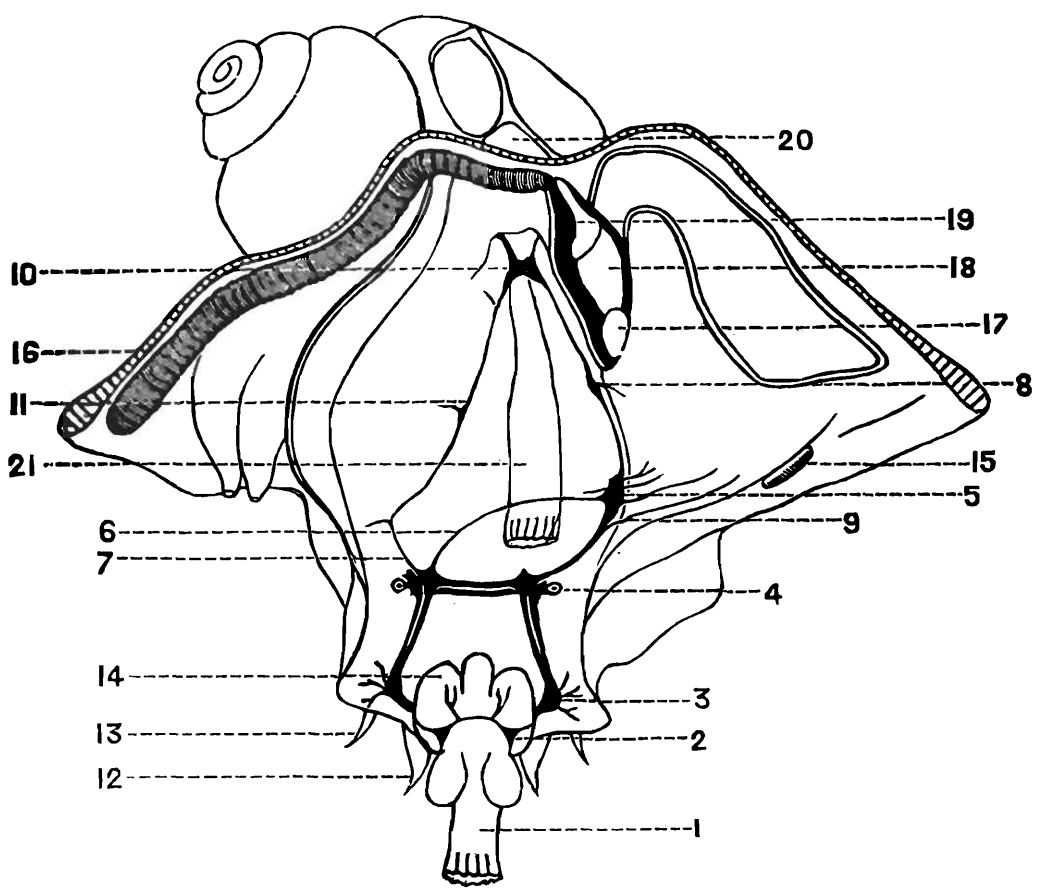
Cerebral ganglion.—Each ganglion is triangular in shape and is situated on the sides of the buccal bulb on its dorsal aspect. From the antero-superior angle of the ganglion is given off the flattened ribbon-like inter-cerebral commissure to the ganglion of the opposite side. The connective lies at the anterior end of the buccal bulb and on its dorsal surface. From the postero-inferior

angle of the cerebral ganglion and from the point below it are given off the large flattened cerebro-pleural and cerebro-pedal commissures.

The nerves from the cerebral ganglia are :—

(1) A nerve to the labial palp of the side. It divides into two branches.

(2) A nerve to the tentacle. It gives off a small branch near its origin to the integument on the outer side of the tentacle.



Dissection of *Ampullaria globosa*:

1, oesophagus reflected forwards; 2, buccal ganglion (left); 3, cerebral ganglion (left); 4, pedal ganglion (left) with otocyst; 5, supra-intestinal ganglion; 6, supra-intestinal nerve; 7, infra-intestinal nerve; 8, accessory supra-intestinal ganglion; 9, pallial nerve (left); 10, visceral ganglion; 11, infra-intestinal ganglion; 12, labial palp; 13, tentacle; 14, buccal bulb; 15, osphradium; 16, gill; 17, ampulla of the heart; 18, ventricle; 19, auricle; 20, kidney; 21, crop.

(3) A nerve to the eye. It supplies a branch from its outer side to the integument of the head.

(4) A nerve to the buccal ganglion through the intervention of a nerve from the latter ganglion.

(5) A nerve to the side of the buccal bulb towards the ventral aspect.

(6) A nerve from the posterior part of the ganglion near the cerebro-pedal connective to the body wall at the back part of the head.

(7) Several small nerves from the inner aspect of the lower border of the cerebral ganglion. Some of these supply the small muscular strands from the integument to the buccal bulb, while others end in the ventral wall of the head.

Both the cerebral ganglia give off nerves having similar distribution.

Buccal ganglion.—Each ganglion is triangular in shape, and is placed at the junction of the oesophagus with the buccal bulb towards the ventral aspect. Each is connected to the cerebral ganglion of the same side by means of a fine nerve. It supplies nerves to the buccal bulb, salivary glands and the crop.

The nerves from the buccal ganglion are :—

(1) A fine nerve from the anterior angle anastomosing with that from the ganglion of the other side. It gives off, a little beyond its origin, a small branch which divides into two branches again supplying the ventral wall of the buccal bulb.
(2) A nerve from the outer angle running up to the dorsal surface of the buccal bulb ; it communicates with the cerebral ganglion of the same side by a fine commissure.
(3) A nerve from the posterior angle which passes backwards to supply the salivary gland of the same side and the crop.

The cerebro-pleural and cerebro-pedal commissures are long, thick, flattened commissures passing downwards and backwards from the cerebral to the pleural and pedal ganglion of the same side respectively. They are placed on the side of the buccal bulb.

Left pleural ganglion.—It is placed in close connection with the pedal of the same side so that the pleuro-pedal commissure is practically absent. It is also connected to the supra-intestinal ganglion by a thick secondary connective, and to the opposite pleural ganglion by a portion of the infra-intestinal nerve which passes through the latter in its course to the infra-intestinal ganglion.

The nerves from the left pleural ganglion are :—

(1) The left pallial nerve which lies at first in the same sheath with the secondary connective between the left pleural and the supra-intestinal ganglion. It then leaves the latter and passes up to the ventral aspect of the mantle flap just behind the thick margin lying in a canal throughout its course. It supplies the mantle and the osphradium. The position of the nerve is marked by a translucent line on the dorsum of the foot.
(2) A small nerve to the left siphon flap.

(3) A number of small nerves behind and laterally to the surrounding structures (including the dorsal portion of the foot).

Left pedal ganglion.—This is closely connected with the left pleural ganglion. It is connected to the opposite ganglion by an inter-pedal commissure. The nerves from the ganglion are :—

(1) A short stout nerve to the otocyst.
(2) Several stout nerves to the foot.

Right pleural ganglion.—This ganglion is similar to that on the left side. It gives off :—

(1) A pallial nerve to the mantle and the penis and penial sheath in male.
(2) The supra-intestinal nerve is given off from the right pleural to the supra-intestinal ganglion.
(3) A nerve to the small right siphon flap.

Right pedal ganglion.—This is similar to the left one in all respects.

The secondary commissure from the left pleural to the supra-intestinal ganglion is a stout and short nerve which lies in a canal on the left side of the dorsum of the foot in the same sheath with the pallial nerve. The position of the nerve can be clearly distinguished by a translucent line on the integument over it.

Supra-intestinal ganglion.—This ganglion is a fusiform body lying in a small sinus of connective tissue on the left side. The cavity in which it lies is covered over by a thin translucent membrane so that the position of the ganglion can be easily pointed out through the integument. The ganglion receives the supra-intestinal nerve from the right pleural ganglion on its right side and is connected to the left pleural ganglion by a secondary connective. The left visceral nerve arises from its posterior end.

It gives off the following nerves :—

(1) An accessory pallial nerve. It arises from the left side of the ganglion and passes up to the mantle flap lying just in front of the posterior border of the thick rim, and parallel to the pallial nerve of the same side.
(2) Two small nerves from the left side of the ganglion passing to the mantle flap. The posterior divides into two branches at a little distance from its origin.
(3) A fine nerve from the right side to the dorsal integument of the foot.

The supra-intestinal commissure is a fine nerve passing from the left pleural over the anterior end of the crop to the supra-intestinal ganglion. The track of the nerve is sometimes represented by a translucent line on the integument over it.

The left visceral commissure is a stout nerve passing backwards along the left side of the dorsum of the foot to the visceral ganglion. Two small nerves are sometimes given off from it to the floor of the mantle chamber.

Accessory supra-intestinal ganglion.—This is a small fusiform swelling on the left visceral commissure. It is present in many specimens but not in all. When present the ganglion gives off two nerves, one from each side, to the integument on the dorsum of the foot and to the floor of the mantle chamber. These nerves are fairly constant, and are present even when the ganglionic swelling is not noticed.

The infra-intestinal commissure passes from the left pleural to the right pleural ganglion; it then leaves the latter and passes along the line of union of the integument on the dorsum of the foot on the right side, being bridged over by numerous fibrous strands throughout the posterior half of its course. The commissure often presents a ganglionic swelling, sometimes two, between the right pleural and the infra-intestinal ganglion.

Infra-intestinal ganglion.—This is a small ill-developed ganglion lying on the right side beneath the crop. It gives off a small nerve to the integument of the right side. The nerve passes outwards to the base of a long fringe-like ridge in the mantle-cavity on the right side. It then divides into two branches, which pass along the base of the ridge in front and behind.

Accessory infra-intestinal ganglion.—A small triangular body giving off a small nerve to the integument on the dorsum of the foot. It lies on the infra-intestinal commissure a little behind the infra-intestinal ganglion.

A still smaller ganglion is sometimes present on the infra-intestinal commissure behind the accessory ganglion.

The right visceral commissure is a fine nerve from the infra-intestinal ganglion to the visceral, lying on a thin membrane extending from the foot to the base of the visceral hump on the right.

The commissure sometimes presents a small fusiform swelling with two nerves from the right side. A small nerve is sometimes given off from the right side of the commissure just before it ends in the visceral ganglion.

Visceral or abdominal ganglion.—This is a triangular ganglion lying on the right side of the pericardium beneath the integument at the base of the visceral hump and behind the posterior end of the pulmonary aperture.

The nerves from the visceral ganglion are:—

(1) A small nerve to the heart.
(2) A stout nerve supplying branches to the stomach, intestine, liver, kidney and reproductive organs.

In conclusion it may be noted that the present species agrees with *Ampullaria carinata* in the general arrangement of the

commissures and of most of the ganglia. But in the present species there is a distinct infra-intestinal (sub-intestinal) ganglion constantly present. Moreover, the presence of one or more accessory infra-intestinal ganglia has been observed in a large number of specimens.

LITERATURE.

1. Bouvier, E. L. "Système nerveux, morphologie générale et classification des Gastéropodes Prosobranches," *Ann. Sci. Nat.* (Zool.) (7), iii, 1887.
2. Lloyd, R. E. *An introduction to biology for students in India.*
3. Pelseneer, P. Article "Mollusca" in *Text-book of Zoology* edited by Sir E. R. Lankester.