XVI. *On the structure of the organs of respiration in animals which appear to hold an intermediate place between those of the class pisces and the class vermes, and in two genera of the last mentioned class.* *By Sir* Everard Home, *Bart. V. P. R. S.*

Read June 1, 1815.

FROM all the facts in comparative anatomy with which we are acquainted, there is reason to believe, that the great scheme of the animal creation is composed of one uniform gradation of structures, and it is only by collecting the different appearances met with in the same organs of different animals, into regular series, that a solid basis can be laid on which a general system may be constructed.

In this view of the subject, every link that is added to any one series, acquires a value; as it increases, in however small a degree, the foundation upon which an edifice of such importance is to be raised, and therefore may not be undeserving of the attention of the Society.

In fishes, the mode of respiration by means of gills is well understood, and there is probably no better criterion by which an animal may be allowed to belong to that class, than its having gills. In the class vermes, confining our observations to those genera that live under water, the respiratory organs commonly met with, are of two kinds, one internal as in the genus Teredo, the other external as in the genus Amphitrite, both of which I have described to the Society upon a former occasion.*

* See Phil. Trans. Vol. lxxv. p. 333.

The materials of the present Paper include five several links in the chain distinct from the gills of fishes, and different from the organs common to vermes; these are met with in the lamprey and lampern, in a new genus intermediate between the lamprey and myxine, in the myxine, in the aphrodita aculeata, and in the leech.

I shall first give a short description of each of these organs, and afterwards explain the modes of respiration.

In the lamprey the organs of respiration have seven external openings on each side of the animal; these lead into the same number of separate oval bags placed horizontally, the inner membrane of which is constructed like that of the gills in fishes. There is an equal number of internal openings leading into a tube, the lower end of which is closed, and the upper terminates by a fringed edge in the œsophagus. These bags are contained in separate cavities, and inclosed in a thorax resembling that of land animals, only composed of cartilages instead of ribs, and the pericardium, which is also cartilaginous, is fitted to its lower extremity like a diaphragm.

In the middle line of the anterior part of the thorax are situated the muscles of the tongue, forming one solid mass, from which a distinct muscle is continued down to the pericardium, sending off fasciculi to the cartilages in the lower part of the thorax.

There is but one nostril, which opens into a cavity of considerable size, having no posterior opening. Where the œsophagus terminates in the stomach, it adheres to the pericardium, and forms an oblique valvular slit, which is closed by the dilatation of the stomach. There is no gall bladder.

In the lampern, the structure of these organs is the same

as in the lamprey, only the cartilages of the thorax are so weak as to appear like ligaments, and the pericardium is membranous.

In an animal brought from the South Seas by Sir JOSEPH BANKS, intermediate between the lamprey and myxine, but differing so much from both as to form a distinct genus, the respiratory organs resemble those of the lamprey in the number of the external openings, and the number of bags, but these organs and many other parts differ in the following particulars, in which they agree with those of the myxine. There is no appearance whatever of thorax, nor is the pericardium cartilaginous; the bags are flattened spheres placed perpendicularly, their cavities are small, their coats elastic, and the internal orifices communicate directly with the œsophagus, which is small. The œsophagus does not terminate in a valvular slit, but in a loose transverse membranous fold; there are two rows of teeth on each side of the tongue, bent downwards, long, and pointed. There is a posterior nostril, and an appearance resembling an uvula. There is a gall bladder, a row of large mucous glands on each side of the belly, and there is a mesentery to the intestine.

In the myxine, the respiratory organs differ from those last described, in there being only two external openings, and six lateral bags on each side, to which there are six tubes from each of the openings, and, close to the left external opening, there is one which passes directly into the œsophagus, the gall duct projects into the intestine.

In the aphrodita aculeata of LINNÆUS, the respiratory organs as well as the other viscera, differ in many respects from those of all the other animals of that tribe. There are thirty-two open-

ings on each side in the intermediate spaces between the tufts of bristles; these all open into a large cavity immediately under the skin and muscles of the back, which is only separated from the cavity of the abdomen by a strong cartilaginous membrane, but there are two rows of spherical cells, fifteen in each, projecting into the cavity with very thin membranous coats. There is no external opening into them, but a slit on the under surface, by means of which, one of the cæca belonging to each of the tubes passing off from the intestine is lodged in each of the cells, which leads me to consider such cæca to be the respiratory organs.

In the common leech, there are sixteen orifices on each side of the belly, which lead to an equal number of spherical cells placed between the abdominal muscles and the stomach, which perform the office of respiratory organs. The particular structures which have been described, are represented in the annexed drawings, (Plates XI. XII. XIII.) which makes a more detailed verbal description unnecessary.

Having described the structure of the organs in these five different genera of animals, I shall endeavour to explain the manner in which respiration is carried on in each.

In the lamprey and lampern, the water is received by the seven lateral openings on each side of the animal into the bags which perform the office of gills, and passes out by the same orifices. The form of the cavities being fitted to allow the water to go in at one side, pass round the projecting parts, and out at the other. A part of the water escapes into the middle tube, and from thence, either passes into the other bags, or out at the upper end into the œsophagus. There is a common opinion that the water is thrown out of the nostril;

this, however, is unfounded, as the nostril has no communication with the mouth. The elasticity of the cartilages of the thorax, admits the water being received, and it is expelled by the action of the muscles drawing up the cartilages and the pericardium. The animal from the South Seas having no cartilaginous thorax, the bags themselves have an elastic covering which keeps them open to receive the water, and it is expelled by the action of the external muscles into the œsophagus.

In the myxine, the elasticity of the two tubes and the bags into which they open, admits of the water being received, and the pressure produced by the action of the external muscles forces it into the œsophagus, from whence it is thrown out by the opening at the lower end of that tube.

BLOCH has given a correct account of many parts of the myxine, illustrated by engravings, but there are several errors respecting the mode in which the water passes out. He supposes it to be thrown out at the nostril. He was probably led into this mistake from finding a posterior nostril communicating with the mouth.

In the aphrodita aculeata, the water passes through the lateral openings between the feet into the cavity under the muscles of the back; it is there applied to the surfaces of the projecting cells, through which the air in the water is communicated to the cæca contained in them: these cæca I consider to be the respiratory organs.

In the leech, the water is received through the openings on the belly of the animal into the cells, or respiratory organs, and passes out by the same openings.

A knowledge of the mechanism employed for the pur-

poses of respiration in the sturgeon, and in the three first genera of animals mentioned in the present Paper, enables us to carry on a regular series of links, in gradation, from fishes in general to the myxine; every change in structure arising out of some peculiar habit of life, belonging to the animal in which it is met with.

In fishes, the gills are so formed, that the water forced from the mouth out at the gills, is applied to them in the most complete manner.

In the sturgeon, while swimming, respiration is carried on in the same manner, but when the sturgeon adheres to any substance by the mouth, which it has a power of doing by extending its lips, some other mode of respiration is required, and it is found that in the act of pushing out the mouth, apparently by the same means, the gill covers are drawn up so as to leave a large channel between them and the gills, through which the water is brought into the mouth and returned through the gills; there is also on the inside of the gill cover the same structure as on the side of the opposite gill, only to a smaller extent.

In the lamprey, the mouth is more constantly employed in laying hold of its prey and other substances, and therefore the respiratory organs are not connected with it, but situated near it.

In the myxine, which feeds upon the internal parts of its prey, and buries the head and part of its body in the flesh, the openings of the respiratory organs are removed sufficiently far from the head to admit of respiration going on, while the animal is so employed.

The respiratory organs in the two last genera mentioned

in this Paper, belong to a series of less complex structures, and perhaps, few animals can have a more simple mechanism than the leech.

EXPLANATION OF THE PLATES.

PLATE XI.

A view of a portion of the lamprey of the natural size, the organs of respiration exposed.

The mouth is laid open, exposing the teeth.

a. The tongue, on which there are teeth turned on one side.

b. The cavity of the mouth.

c. The fauces.

d. The tube between the bags containing gills.

e. Its termination in a loose edge at the orifice of the œsophagus.

f. A firm cartilage in the centre of the retractor muscles of the tongue.

gg. Two large salivary glands.

hh. The cavities containing a structure like gills laid open through their whole extent.

ii. The external orifices of these cavities.

kk. The internal orifices.

ll. The cartilages of the thorax.

m. The cartilaginous pericardium.

n. The termination of the œsophagus in the stomach.

Plate XII.

The respiratory organs in an animal from the South Seas, and in the myxine.

Fig. 1. These organs exposed in the animal from the South Seas.

a. The external nostril.

b. Internal nostril.

c. A tooth on the roof of the mouth.

dd. The tongue split, showing two rows of teeth on each side.

ee. The muscles of the tongue divided and turned aside.

ff. The œsophagus.

gg. The external openings into the respiratory organs.

hh. The internal ones,

ii. The organs themselves.

Fig. 2. One of the bags or organs laid open.

Fig. 3. The same parts in the myxine.

a. The external nostril.

b. The internal nostril.

c. A tooth in the roof of the mouth.

dd. The tongue split, showing two rows of teeth on each side.

ee. The muscles of the tongue turned aside.

ff. The œsophagus.

g. The stomach.

hh. The two external openings leading to the organs.

i. The opening leading to the œsophagus.

kk. The tubes leading to the organs.

ll. The internal openings.

mm. The organs themselves.

nn. The mucous glands.

PLATE XIII.

The respiratory organs in the aphrodita aculeata and leech.

Fig. 1. Back view of the aphrodita aculeata.

Fig. 2. The respiratory organs laid bare by removing the skin and muscles of the back.

aa. The cells projecting into the cavity under the muscles of the back.

bb. The external openings leading into the cavity.

c. The gizzard exposed, the thin cartilaginous covering seen on the opposite side having been removed.

d. The intestine.

ee. The lateral tubes going off on each side.

ff. The cæca, which project into the cells.

Fig. 3. The hirudo medicinalis laid open from behind, the stomach removed, exposing the respiratory organs, consisting of thirty-two transparent cells, in each of which the external orifice is seen through the coats.

The spinal marrow with its ganglia and nerves distinctly seen.

aa. The respiratory cells.

bb. A large blood vessel on each side.

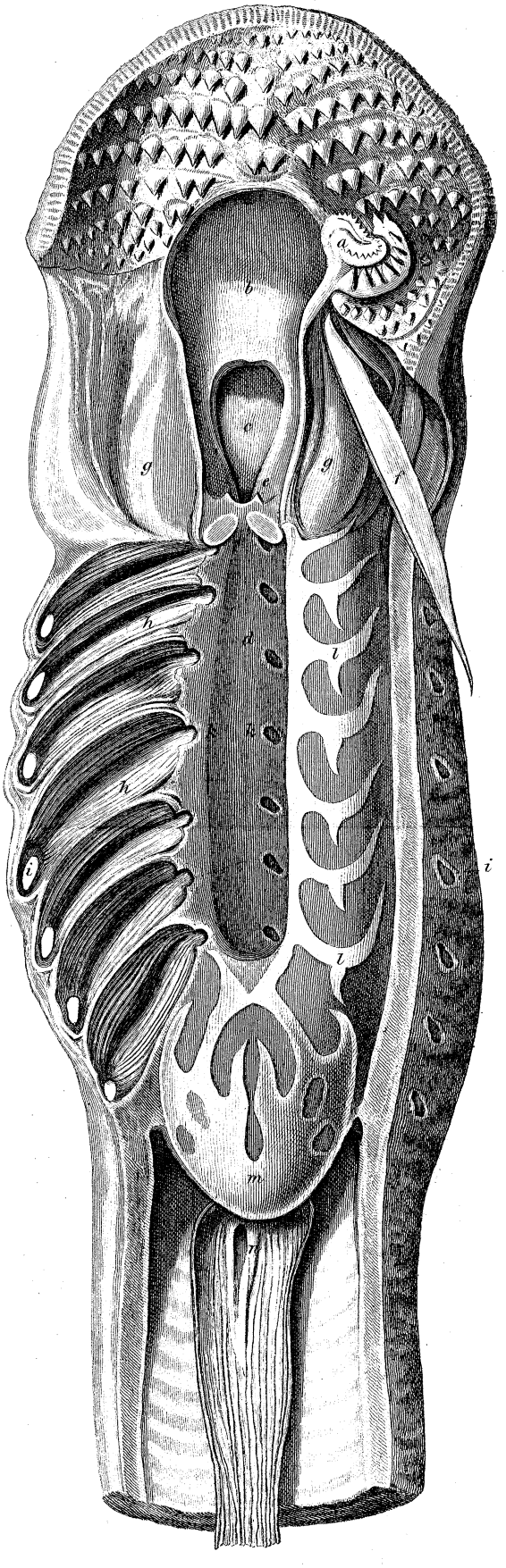
cc. Mucous glands.

dd. Glandular structures communicating with the testicles.

ee. The testicles.

f. The penis.

g. The uterus.



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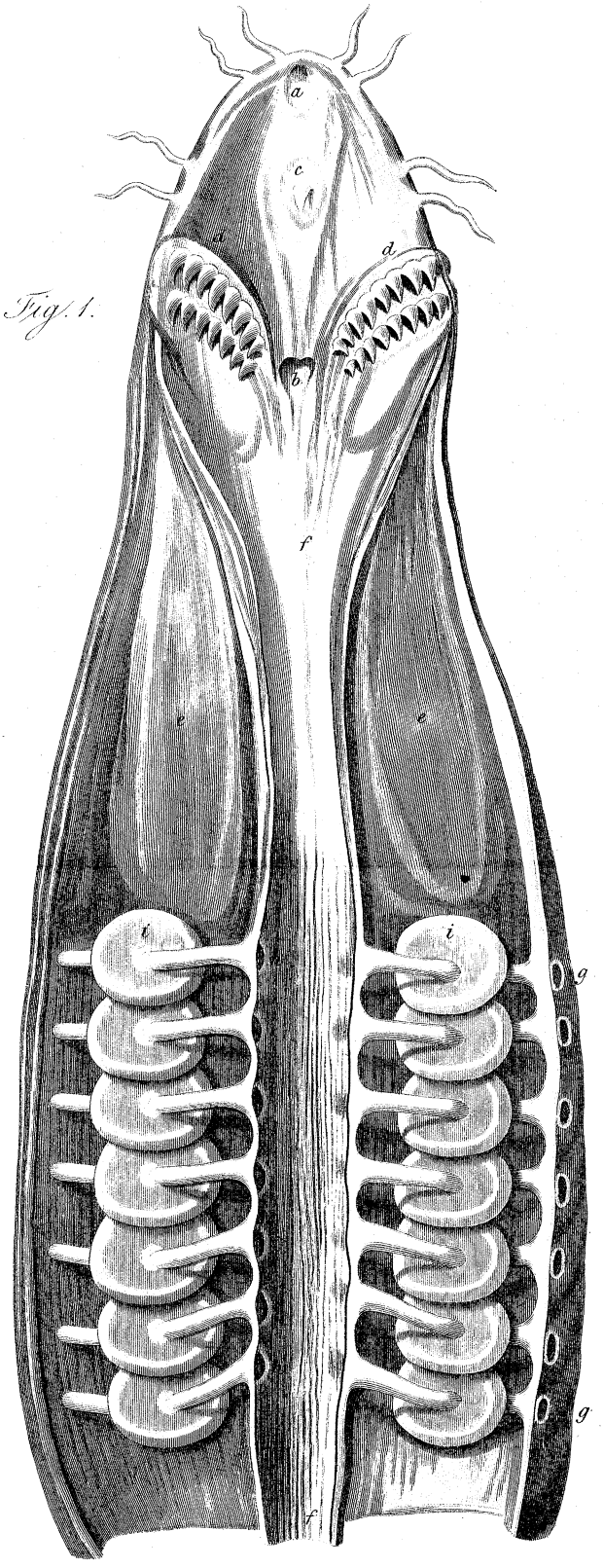

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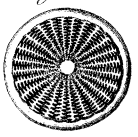

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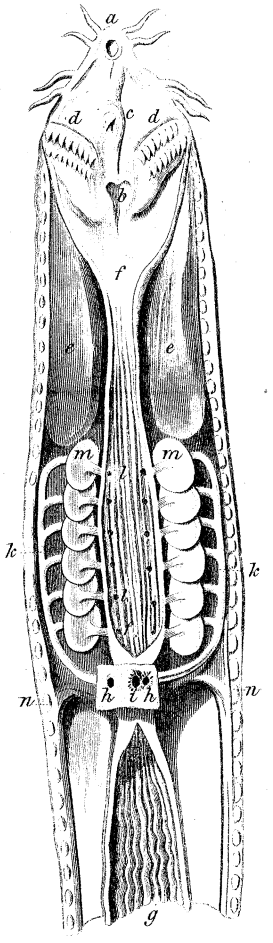

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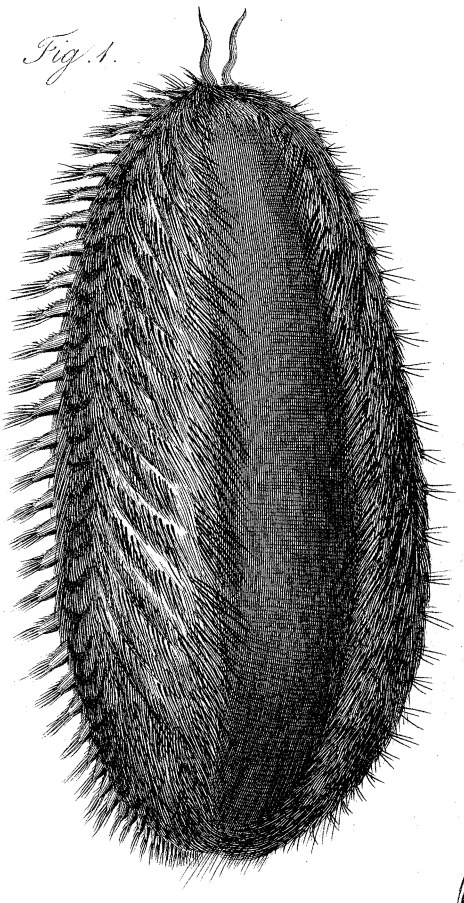

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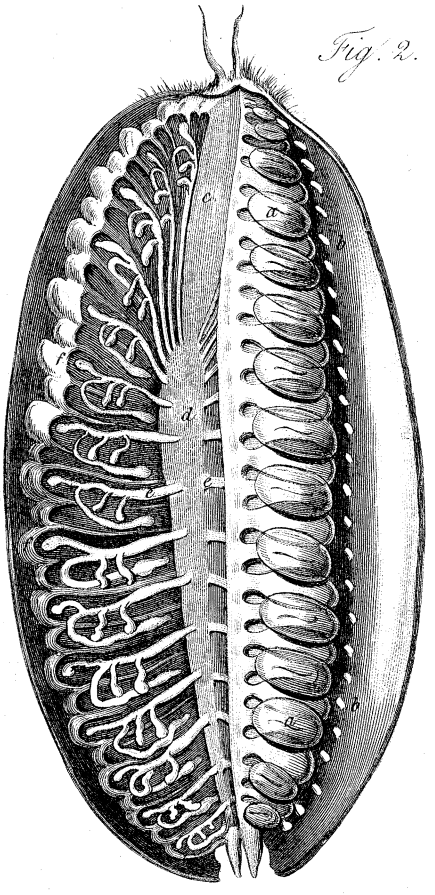

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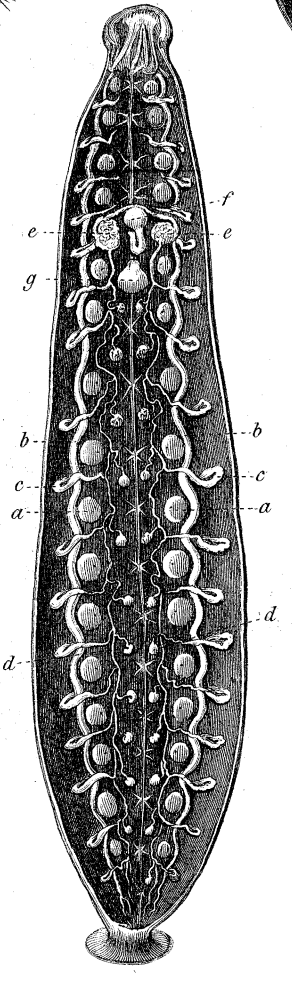

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