On the Anatomy and Physiology of Amphioxus.

By M. P. Bert.

The existence of *Amphioxus* has been ascertained, during the month of March of this year, in the muddy sands of the basin of Arcachon, by MM. Fillioux and Lafont. This is the first time, to my knowledge, that any one has found it on the oceanic shores of France.

From March to May all the individuals have the generative organs filled with eggs or with spermatozoids in different degrees of development. After this period these organs are empty and atrophied. Like all fishes, the *Amphioxi* are fit for reproduction before they have attained their full size. No difference can be ascertained between the male and female, even when the generative sacs are filled with their products, except with the aid of magnifying-instruments. The number of these pouches is, in both sexes, from twenty-two to twenty-six; that of the muscular masses is sixty-one pairs; but that of the branchial spaces varies considerably with the size, as has long been known (an individual of the length of 20 millimetres has 93 spaces, one of 30 millimetres 153). This augmentation takes place at the two extremities of the branchial apparatus; of this we may easily be assured by taking for point of reference the anterior extremity of the liver, which always corresponds to the sixteenth muscular mass. Beyond the abdominal pore the coats of the body do not closely embrace the intestine, as M. de Quatrefages says. I have, on the contrary, verified the assertion of J. Müller, who describes a prolongation of the peritoneal cavity going to the anus. It is true that the particles which have traversed the branchial network never get into this passage, which is sometimes obliterated by the contractions of the coats of the body. On the other hand, I cannot admit the existence of the lateral canal (prolongation of the general cavity) which according to some anatomists opens at the side of the mouth.

Each of the ovarian sacs consists of a thin wall furnished with pavement-epithelium, of which the very pale cells measure about 0·01 millim. Within, separated from the sac by an interval full of a transparent liquid, is the ovigerous sac, which is extremely thin and without epithelium when the eggs are developed; but when these first make their appearance, it possesses epithelial cells 0·010–0·014 millim. These cells group themselves round the young eggs, which appear to originate only in contact with the wall. The smallest that I have seen were 0·038 millim., their germinal vesicle 0·009 millim., and their germinal spot 0·004 millim. I have found them in the same sac from that size to 0·24 millim., which is that of the mature egg (vesicle 0·09, spot 0·026 millim.). The vitellus becomes opaque when the egg attains 0·085 millim. I have seen at the same time in the sac some isolated corpuscles which had all the characteristics of the germinal vesicle. When the eggs are mature, they lose their spot and vesicle, and, being compressed in the sac, form at its surface an elegant mosaic. They then emerge by the bursting of the sac and pouch: in the wall of the former some pigment-granules are developed; it then contracts and becomes invisible.

I have not been able to trace from its commencement the appearance of the spermatozoids; I have, however, once seen them united by the head, in great numbers, in their mother cells (male ovules); the latter then burst, and the spermatozoids group themselves in a single bundle in a large sac with thin walls without epithelium. Between this sac and the testicular pouch float a number of corpuscles measuring 0·0045 millim., the nature of which is unknown to me.

I cannot regard the dorsal cord as formed of cells (Quatrefages) or of disks (J. Müller &c.). Longitudinal sections showed a more regular structure, namely lamellæ composed of semisolid amorphous material. But these lamellæ towards the centre of the dorsal cord are forked in proportion as they recede from that centre, giving origin to secondary lamellæ in gradually increasing numbers, which do not reach the whole surface of the dorsal cord. Hence arise those parallel lines which have led to the belief in juxtaposed disks, and which, occupying a part of the circumference, have been regarded by M. de Quatrefages as limiting large flattened cells. Nor can I share the opinion of M. Marcusen, according to which the large bodies contained in the cells of the fin on the one hand, and in the swelled extremity of the spinal marrow on the other, are composed of capillaries. In the first place, the large bodies are translucid and homogeneous, whilst the swollen extremity (so well described by M. de Quatrefages) is filled with corpuscles perfectly similar to those which strike us at the first glance in the spinal marrow. Secondly, in some fragments of *Amphioxus* which had been cut for several days, and were still living, these parts preserved their dimensions, which would not have been the case if they had been composed of capillaries full of blood. The spinal marrow contains, both in the swollen and contracted parts, some cells which are very difficult to see clearly. They did not appear to me to be round, as is generally stated, but angular or polar. I have seen from an angle on one of them, which was tripolar and measured 0·015 millim., a fibre originate and soon become bifurcated.

The manifest contradiction between the description of M. de Quatrefages and that of M. Marcusen with regard to the termination of the cutaneous nerves appears to me to be founded on a premature generalization. If we examine the cutaneous nerves in the middle and posterior regions of the body, we find them ramifying more and more, losing their proper envelope, and at last becoming so fine that their extremities cannot be distinguished. I have reason to believe that they present anastomoses in their course. But the nerves which proceed from the facial trunks (second, third, fourth, and fifth pairs of Quatrefages) behave differently; after a short course, they arrive at some oval cellular bodies, measuring from 0·012 to 0·015 millim., filled with granules, with one or two nuclei of 0·004 millim. These cells, pointed out by Quatrefages, are the very terminations of the nervous filaments; but they only exist for the facial filaments, in which they undoubtedly indicate some particular function.

The anterior termination of the spinal marrow of *Amphioxus*, although not inflated, nevertheless plays the part of an encephalon;

if it be cut away, the animal, when once at rest, remains immoveable upon the sand, without any indication of voluntary determination. But it is still extremely sensitive, and regularly executes the movements of the muscles of the belly which aid in respiration. I have seen the general reflex movements persist for more than a week in a decapitated *Amphioxus*.

The immersion of an *Amphioxus* in sea-water charged with blue litmus (Vulpian's method) furnished no evidence of an acid secretion in its intestinal tube, unless perhaps in the buccal cavity. As to the large greenish appendage which is usually denominated the liver, I have been unable to perceive, under the microscope, the production of violascent spots by the action of acidulated tincture of iodine; hot nitric acid gives it a rather bright bottle-green colour.

Neither in the liver and excrements, nor in those singular bodies, differing in different animals in number, size, and position, which J. Müller regards as the kidneys, could I detect the presence of uric acid by the microscopic reaction of murexide.

I believe I am the first to have witnessed the ejection of the semen; it issues by the abdominal pore in a continuous jet, reinforced by pulsations due to the abdominal muscles; the spermatozoids, which are free and active, retain their movements for about twenty-four hours in sea-water (at 59° F.). They then measured:—head 0·003; tail 0·040–0·048 millim., but generally 0·045 millim. The detection of this spontaneous emission of the semen is important, as it compels us to regard the *Amphioxus* as an adult and definitive form.

If the extremity of the body of an *Amphioxus* be cut off, the wound does not cicatrize; on the contrary, the tissues become gradually disintegrated. I have seen animals, with only the tail mutilated, become gradually eaten away up to the middle of the branchial region, and live thus without intestines, without abdominal walls, and without branchiæ for several days. In this destruction the disks of the dorsal cord become detached, and the muscular fibres become dissociated, lose their striæ, and disappear: the wound acquires a rosy colour.

Immersion for two minutes in water at 106° F. kills the *Amphioxi*; but although incapable of spontaneous movements, they are still locally contractile. Fresh water kills them with convulsions in two or three minutes; they then become opaque and rigid, and their muscles no longer contract, even under the influence of induced currents insupportable by the dry fingers. If, then, the animal be again placed in sea-water, contractility is seen to return in a few hours, and then sensibility. If the cessation of the movement of the vibratile cilia has been waited for, it reappears in sea-water, but contractility and sensibility are finally lost.

The presence in water of a very small quantity of strychnine kills the *Amphioxi* with tetanic convulsions; morphine stupefies them (even when the cephalic extremity has been removed), leaving them, however, when in small quantity, their sensibility; lastly, curari renders them immobile without affecting their contractility, and this even when their integuments are uninjured.—*Comptes Rendus*, August 26, 1867, pp. 364–367.