

Xenopleura vivipara, g. et sp. n. (Enteropneusta).

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With Plates 42 and 43.

SOME four years ago, while examining a rocky part of the coast of False Bay at very low tide, I found a small *Banaglossus* different from the species (*Ptychodera capensis*), which is not uncommon near the locality. The difference was most obvious in the absence of the conspicuous genital pleurae, and the presence of a small number of rounded branchial apertures.

The specimen was put aside for further examination, as only the single one was obtained. Repeated attempts, in successive years, at the same season, and at the same localities, to procure additional and better specimens were without success. This specimen was therefore sectioned to ascertain if there were any features of special interest beyond the probability of its representing a new species. Examination of the sections showed that the specimen was of particular interest in several respects, the most outstanding of which was that the body contained a well-advanced embryo. Further examination showed also that the notochord had a structure and form apparently different from any hitherto recorded, and that the dorsal nervous system presented some peculiar features. As there seems little likelihood of procuring more material at present, the more outstanding and interesting features of the single specimen are described.

Habitat.

The Enteropneusta are usually found on sandy or gravelly coasts, but this particular individual was found in the crevice of a rock at a specially low tide, a fact which may account for its apparent rarity. Its finding was accidental. The material in which it occurred was removed and examined in the laboratory, as it appeared to contain a specimen of a large *Phoronis*. This proved to be a *Phoronopsis*, and, as this animal has hitherto been found only in limestone rocks from the deeper waters of False Bay, a similar habitat for the *Balanoglossus* may be indicated. The handful of material consisted of small stones, shells, and sand containing hydroids, a few polychaetes, and the *Balanoglossus*, which was readily recognized when removed from a mucous mass of debris which surrounded it. Its colour was of the normal type, the proboscis and collar being yellow, the posterior parts greyish yellow. The advanced ova shone through the body as light red patches. The behaviour of the animal was different from that of other *Balanoglossus* examined, for its movements were particularly sluggish, a fact which may be associated with its condition, as shown by subsequent examination. It was left in clear water for a time to get rid of the contents of the alimentary canal for subsequent sectioning; but it soon ceased to move and was preserved, no sand having passed out of the body, as is usual in other species. The animal appears to differ from most Enteropneusta in not being a tubicolous, sand-feeding form, and this may account for some of the peculiarities of its bodily structure noted below.

External Characters.

The species is small, being, in the living condition, about 30 mm. in length and 2 in breadth. The proboscis is rounded, almost circular in outline, the collar well marked at its anterior margin, but posteriorly not very clearly distinguishable from the body. A small but well-marked median notch was observed in its upper margin, the sides of which ran from this point downwards and obliquely backwards to the underside of the

body. The gill openings were distinguishable, being small circular pores with clear margins. Four pairs were distinguishable in the living animal, the first pair being close to the second and wider apart than the succeeding pairs. They began close behind the collar, and ended at about the anterior fourth of the body. No hepatic caeca were visible nor genital pleurae. On preservation the shape of the body altered considerably. It became shorter and much narrower, except in the anterior region which was subsequently found to contain the embryo.

Proboscis.

The greatest breadth of the proboscis in sections is 1.8 mm. It is slightly flattened on its upper side anteriorly, and this becomes more marked towards the posterior end. The epidermis is not thick, being about 0.05 mm., which is also about the average thickness of the nerve-layer under it. Dorsally and ventrally the nerve-layer is somewhat thicker at the anterior and middle parts of the proboscis; posteriorly on the dorsal side it becomes much thicker above the central proboscis complex. Below it is a thin layer of circular muscles of about the same diameter. The longitudinal and radial muscles are well developed, and the space between them and the central complex of the notochord, glomerulus, and pericardium is filled with connective tissue. The longitudinal muscles are not so well developed, nor arranged in bundles, as in *Ptychodera* and other genera. The radial muscles, which become more abundant towards the posterior and ventral region of the proboscis, are well developed.

At the anterior end of the proboscis, on its ventral side, the epidermis is thrown into a number of folds, and the nervous tissue below it is much more developed than at the dorsal side of the same region of the proboscis. These projections may represent a sensory or adhesive organ.

There is, at the anterior end, a cavity filled with connective tissue. It begins near the tip of the proboscis and passes along above the foldings of the epidermis, being in this region much

wider than deep. More posteriorly the cavity changes shape, becoming narrower and deeper; at first V-shaped and reaching to the axis of the proboscis, it ultimately assumes the form of an elongate fissure extending from the ventral epidermis to the axis. Here it becomes filled with an extension upwards of the circular muscles in place of connective tissue. It finally disappears posteriorly as a short tubular extension in the axis of the proboscis. For about 26 mm. posterior to this the proboscis presents a homogeneous mass of longitudinal and radial muscles, without trace of the central complex, which begins at the posterior fourth of the proboscis.

Two other cavities are dorsal in position, and begin above the anterior end of the glomerulus as a small single cavity; a little more posteriorly, where the pericardium becomes connected to the dorsal aspect by a dorsal septum, the cavity, which has become very much wider but low, is divided into two. Neither of the cavities extend downwards to embrace any part of the pericardium, glomerulus, or notochord. Posteriorly the cavity on the left side becomes smaller, and towards its posterior extremity, where it comes into contact with the left side of the pericardium, opens into a rather wide funnel-shaped aperture lined by definite cells. This leads into a short but wide tube, lined by a very definite low epithelium, and, passing, from the side to the dorsal aspect of the notochord, opens to the exterior forming the single narrow proboscis pore.

The left dorsal cavity has also a connexion with the exterior, but not so clearly marked. There is no conspicuous funnel-shaped opening as in the right, but it can be followed backwards into a narrow tube, which passes over that of the left and opens into it, having no separate dorsal pore. Figure 3, Pl. 42, represents a section passing through the two tubes.

The ventral posterior extension of the proboscis cavity, so well marked in some species, is present here, but in a much reduced condition. It is represented by two layers of cells, under the notochord, enclosing a space, which a little farther back becomes divided into two. There is no racemose organ.

The 'pericardium' consists of a single unbranched, more or less triangular tube, of a layer of epithelial cells. It extends forward some distance beyond the notochord. Posteriorly it becomes more quadrangular in shape, and, on the left side, comes into direct contact with the left dorsal proboscis cavity.

The central blood-sinus is normal, at places filled with blood and projecting into the pericardium; at others it is in a collapsed condition, devoid of blood, as if its method of contraction were in the form of a peristaltic movement.

Notochord.

The notochord, which is of more interest, is a comparatively simple structure in the proboscis, and has no lateral pouches. About the middle of its length in the proboscis, where the glomerulus is best developed (fig. 2, Pl. 42), it consists of a central part, containing a small lumen, round which is a layer of nuclei. These represent an inner epithelium of non-vacuolated cells. Radiating from these centrally placed nuclei to the periphery is a number of protoplasmic strands with nuclei, representing the vacuolated cells. The diameter of the notochord is here 0.085 mm. This continues forwards for several sections, the central part with its nuclei gradually approaching and ultimately reaching the lower side of the chord at its anterior end. The central lumen disappears abruptly together with its nuclei and the chord is not continued beyond this point, though the central blood-vessels and pericardium are. The diameter of the chord has become reduced, being about 0.05 mm. (fig. 1, Pl. 42). Posterior to the glomerulus the notochord, still retaining its circular outline, becomes somewhat larger, being about 0.1 mm. in diameter. A definite layer of nuclei now appears at its periphery, along with the ventral septum. At the posterior end of the proboscis the lumen becomes much larger and drawn out laterally to about 0.05 mm., and, together with its surrounding nuclei, which have increased in number, has moved to the dorsal side, while the radiating strands of the vacuolated cells now appear on the ventral side

only. The encircling layer of nuclei of the splanchnic epithelium is confined to the ventral side and passes downwards to form the ventral septum. It is embedded along with the passage of the dorsal pore in chondroid tissue, resting on the nerve fibrils of the epithelium of the neck (fig. 3, Pl. 42). In sections posterior to this the vacuolated cells disappear, leaving only the central cavity surrounded by nuclei. The notochord has now entirely lost its notochordal appearance, and is continued in the collar region below the dorsal nerve-chord as a mere tube about 0.017 mm. in diameter, consisting of low non-vacuolated cells surrounding a narrow lumen (fig. 4, Pl. 42).

Towards the posterior end a few protoplasmic strands begin to appear in the lumen, and these gradually increase in number, especially laterally, the chord meanwhile becoming broader and deeper. Finally the lumen disappears altogether, the whole consisting of a central mass of vacuolated cells (fig. 5, Pl. 42).

There is no trace of lumen here, but a few sections farther back there appears below the notochord a circular layer of nuclei, derived from the external basal nuclei; and this, about five sections farther back, becomes connected with the oesophageal epithelium, as shown in fig. 6, Pl. 42. The notochord now rapidly increases in size posteriorly, and a few sections farther on a lumen appears again, first on the right side (fig. 7, Pl. 42), but gradually increasing in size till it occupies the whole centre of the vacuolated cells, attaining a breadth of 0.34 mm. (fig. 8, Pl. 42). This occurs at the posterior end of the collar region, just where the posterior neuropore begins (fig. 11, Pl. 42). The notochord here attains its greatest development. In structure it is essentially similar to the anterior part or 'stomochord', but is very much larger, and is not circular in outline, but drawn out laterally. Its lumen is surrounded by a crowded layer of nuclei, from which radiate outwards a number of protoplasmic strands, which in the interior tend to become reticulate. The vacuolated cells constituting the notochordal tissue are clearly marked off from surrounding tissue, not only by their structure, but by an enveloping layer

of homogeneous substance (fig. 8, *sk*"., Pl. 42) apparently secreted by them. On each side the notochord passes abruptly into a low single-celled epithelium, forming a sort of pocket, in which, as in other forms of the Enteropneusta, the limbs of the skeletal elements are enclosed. This skeletal substance is continuous with the layer of homogeneous substance encircling the notochord above mentioned, and, in both cases, it is produced into fine projections to which are attached the muscles occupying the body cavity of this region. It is the produced ventrolateral aspect of the notochord to which the muscles are attached; at the dorsal and dorso-lateral region of the notochord the homogeneous sheath is not produced in this way, but forms a simple layer. This lateral projection of the notochord serves as a point of attachment for the muscles of the body. It may be particularly noted that the cells of the epithelium of the other parts of the oesophagus are not vacuolated here (figs. 7 and 9, *c.oe.*, Pl. 42), and the passage to the gills is kept open only by the broad rigid notochord. In species of the Enteropneusta which I have examined, and in others, so far as I am aware, the dorsal wall of the oesophagus, though having vacuolated cells, has no such development and no lumen, and further, is not differentiated from the rest of the oesophageal epithelium, which has the cells also more or less vacuolated in these species.

Another feature, which may be noted in this region of the notochord, is its relation to the dorsal nervous system. On its dorsal surface is a shallow depression with slight upward elevations on each side, and in this lies the nerve-chord closely applied to it, being separated only by a very much reduced perihæmal space and blood-sinus.

Posterior to this region there are considerable changes in the notochord. In the median line it ceases abruptly, though it appears again a little farther back. The lateral parts, however, increase in size, and are continued backwards as two stout supporting structures on each side of the oesophagus. These lateral prolongations—parachords they may be called—extend into the gill region, and can be traced backwards over

thirty-four sections from their commencement, or for a length of 0.272 mm. They are lodged in pouches, and distinctly separated from the remainder of the oesophageal epithelium and from the lower part of the skeletal element (figs. 9, 10, 12-15, *par.*, Pls. 42 and 43).

Posterior to the first gill opening the skeletal element disappears, though the parachords are continued backwards. The pouch, in which they are lodged, gradually opens up, its tissue loses its reticulate aspect, and merges into the general epithelium of the lower part of the oesophagus. It is still vacuolated, however, as are also the cells of the lower part of the oesophagus here, a fact worthy of particular mention (fig. 15, *par.* and *r.c.*, Pl. 43).

Following the median dorsal part of the notochord backwards, we find that, in a few sections posterior to that shown in figs. 8 and 11 (Pl. 42), it opens by a wide opening into the oesophagus; the floor of its cavity of course disappears, the upper part being continued as the dorsal epithelium of the oesophagus. The cells constituting it, however, abruptly change in character and lose the vacuolated condition (fig. 12, Pl. 42), and it is thrown into folds. These folds are not regular and are apparently a result of shrinkage in the preserved tissue, for there is less rigidity of the epithelial layer, in the absence of the vacuolated cells. Posterior to the folding the epithelium assumes a more specialized aspect, for vacuolated cells begin to appear in it, forming a marked groove (fig. 9, *not.*, Pl. 42) on the roof of the oesophagus. The layer spans the large space between the walls of the oesophagus here; a little farther back, however, where the first gills appear, this space is much narrower, and here the upper oesophageal epithelium assumes the form of a narrow but deep group of vacuolated cells (fig. 10, *ep.b.*, Pl. 42). Posterior to this region the group of vacuolated cells projects more or less, and forms the typical epibranchial band, a ridge in place of a groove in the roof of the oesophagus. Behind the anterior gill there is an antero-posterior involution of the dorsal wall of the oesophagus, so that the position of the band, arrangement of the gills and

branchial portion of the oesophagus seem at first somewhat complicated (fig. 15, Pl. 43). This folding is not accidental, and its effect is to increase the inner superficial area of the pharynx and provide for the access of water to each gill, for the inner openings of all the gills are separate from each other and not combined into groups with a common aperture, like the external openings. One result is that the external openings of the first pair are close to and outside those of the second. The condition becomes normal a few sections farther back. In the region of the second gill opening it begins to disappear as a projecting band, but the main body of the vacuolated cells remains and is still associated with the skeletal elements (*slc'* in figures), which support the upper gill-pouches of this region. The branchial skeleton is thus very poorly developed, and the branchial portion of the oesophagus has more or less collapsed in the preserved condition.

More posteriorly the last gill appears as a simple structure at each side of the body, and here the epibranchial band of vacuolated cells has almost disappeared.

The epibranchial band has associated with it the same skeletal elements as accompany the notochord and its pleurochordal branches. This is best shown in a section passing through the first gill opening (fig. 14, Pl. 43), in which, at the base of the band, there appears on each side, between it and the gill-pouch, the first indication of the branchial skeleton. This is in the form of a semi-lunar patch of tissue, applied to the inner side of the rounded branchial pouches. These two patches are connected with each other in the middle line below the band. More posteriorly, where the gill-pouches are farther apart, the skeletal elements are not so connected. At intervals branches or gill-bars are given off to lend support to the gills. These are small in the anterior region, and do not assume the form of bars, but, at the posterior region, there are a few long bar-like elements with, however, no connecting syntactula.

Notochord in Embryo.

The notochord does not appear in its typical form of vacuolated cells in the proboscis, though the central blood-sinus and pericardium are well represented. At one place, however, at the ventral side, where the proboscis joins the neck, there is a group of cells showing the typical vacuolations. This part corresponds to that in a similar position in the adult (fig. 3, Pl. 42); otherwise the notochord consists of a small group of cells surrounding a central space. It is continued as such into the collar, and opens out widely a little posterior to the bifurcation of the skeletal elements. This opening is similar to the condition found in other Enteropneusta, where it is in the form of a wide arch forming the roof of the oesophagus, terminating on each side in a recess, below which the lateral walls of the oesophagus projects inwards in the form of a small ledge. In succeeding sections the recess may be followed till it merges into the oesophageal diverticulum forming the first gill-pouch. Meanwhile, above it, another recess is being formed by an outgrowth of a second ledge on either side, and, a few sections farther on, these two projecting ledges meet each other in the middle line, forming a bridge. This is doubtless a stage in the formation of the posterior part of the collar notochord of the adult. The bridge disappears entirely in the next two sections, and the whole of the side of the oesophagus is occupied by the enlarging gill-pouch. There is, however, no trace of vacuolation in this part of the notochord, and the stage is not sufficiently advanced to indicate how the adult structure arises.

It is of interest to note that the first pairs of recesses, which are apparently similar to those which are very conspicuous in some species, are here continuous with the first gill-pouch.

Nerve-chord and Medullary Folds.

Anteriorly, behind the neuropore, the nerve-chord has no epidermal connexion, and lies rather deeply at a distance from the external dorsal epidermis about equal to double its vertical diameter. Eight sections farther on this distance is

only half its diameter, and, about the same distance farther back, its epithelial part is in contact with the base of the external epithelium, just beyond the bifurcation of the skeleton of the notochord. Then what looks like a very stout dorsal root appears forming a connexion with the external epithelium, but opens out into two medullary folds to form a large posterior neuropore. The nerve-chord here assumes a flattened plate-like form (figs. 8, 11, 12, Pl. 42).

The space between the two medullary folds, the left of which is larger than the right, gradually widens, and they assume the form of two ridges occupying the position of genital pleurae in other species (fig. 14, Pl. 43). They extend backwards on the dorsal aspect of the body, passing the first gill opening on its outer side. At this point, though losing the general appearance of dorsally projecting pleurae, they may be followed backwards and downwards as elevations or lateral folds on each side of the body (fig. 15, *l.f.*, Pl. 43), till they meet on the ventral side, where they form a conspicuous foot-like organ (fig. 16, *ft.*, Pl. 43). This extends backwards to a point between the second and third gill opening as a single structure attached to the body. More posteriorly it divides into two, and is continued ultimately as two lobes free from the body (fig. 17, *ft.*, Pl. 43).

That the medullary folds pass into these dorsal pleurae cannot be doubted, but that they pass down the sides of the body and unite to form the foot is not so evident, especially as the right pleura ends as such rather abruptly. The mode of formation, however, of the medullary folds and the nerve-chord as seen in the embryo leave no doubt on this point. Here the foot is a relatively large organ. Posteriorly it is free from the body; but farther forward, where it joins the body, it is well developed, and sends up lateral outgrowths resembling the large parapodia of some tectibranch molluscs (fig. 18, *ft.* and *l.f.*, Pl. 43). More anteriorly these lateral parts become fused with the sides of the body and ultimately completely encircle it, coming into relation with the dorsal nerve-chord. It is the upper free edge of the parapodia that first does so.

The details of this are somewhat complex, and will be described later, but this is sufficient to indicate that the foot, lateral projections, pleurae, and medullary folds of the adult are essentially the same continuous structure. It will be observed also that the difference between the two pleurae of the adult seems to be here indicated, for at the extremity of the right in the embryo is a part encircling a space, and this part arises independently of the remainder of the foot as a separate diverticulum of the body-cavity.

Besides the notochord and medullary folds there are one or two interesting features in the animal which may be mentioned, and which are worthy of attention when fuller and better material is available, such as (1) the branchial skeleton and simple saccular gills, which are well developed, several opening to the exterior by a single external aperture anteriorly, but the last reduced to a mere intestino-epithelial canal; (2) their development, as shown in the embryo, where the gill-pouches are conspicuous diverticula of the enteric canal, not yet connected with the ectoderm. The post-branchial portion of the body of the adult has unfortunately been damaged, but (3) there are modifications and thickenings of the intestine, which apparently represent internal hepatic caeca; (4) the mature ova are relatively large (fig. 18, *ov.*, Pl. 43), and the gonads extend far back beyond the branchial region. The collar-pores opening into the first branchial aperture (fig. 14, *et'*, Pl. 43) lead into a rather long tube opening out into a wide and elongate funnel internally, having the appearance of a 'nephridium', as do also the proboscis pores. The embryo is complete and well preserved, and will be described in detail at a later date, perhaps with additional material.

SYSTEMATIC POSITION.

The genus, which I name *Xenopleura*, on account of the anomalous development of the medullary folds over the sides of the body, seems to differ from the other Enteropneusta. It approaches nearest to the Harraminiidae as defined by Spengel

in 1912, but presents certain features which seem to necessitate its separation from all the genera included in this family. The genus may be described as follows :

Xenopleura, g.n.

Medullary folds extending posteriorly into low pleurae, and continued behind the first gill opening as oblique ridges across the sides of the body, fusing on the ventral aspect, and continued for a short distance free from the body.

The 'stomochord', the cavity of which is occluded posteriorly, is continued without interruption beyond the bifurcation of skeletal element, and appears as a well-marked definite group of vacuolated cells with a lumen.

This opens into the oesophagus, behind the posterior neuropore, where it abruptly ceases centrally, but is continued on each side as two parachords, lying in an involution of the enteric epithelium, external to the gills.

The central part, though now non-vacuolated, appears again a short distance posteriorly as a shallow groove of vacuolated cells, which is continued backwards between the gills as the epibranchial ridge.

There is one proboscis pore, no synapticula, and the last gill-sacs assume the form of epithelio-enteric openings. The proboscis is not elongate. No nerve-roots. Pericardium simple.

Xenopleura vivipara, sp.n.

The species is comparatively small in size. The eggs are relatively large, and of a red colour. The species is viviparous. There are two excretory tubes, one of which is smaller than the other, and passes over it to join the opposite side, both opening to the exterior by one common pore. No external liver-sacs.

GENERAL REMARKS.

Though interesting and apparently new, there is nothing very remarkable in the fact that a species of the *Enteropneusta* is viviparous, though the further development of such

a form may throw more light on the ontogeny of the group than the study of the pelagic larval stage.

The continuation of the medullary folds into small pleura and lateral folds meeting below, indicate only a modification of the collar region. Its great development in the larva suggests that the collar of *Enteropneusta* may be a modification, for a special mode of life, of an ancestral ventral crawling organ.

With regard to the existence of a notochord, comparable to that of the vertebrates, there is still a wide difference of opinion, and on this question the species under consideration seems to throw some new light. The notochord of the vertebrates may be defined as a supporting band or rod of vacuolated endoderm cells differentiated locally and histologically from other endodermal cells. It may appear in two chief forms, (1) as a groove or thickening of the endodermal cells (in the embryo) and (2) as a definite rod-like tract cut off from the enteric canal, and it has been suggested (Masterman) that there is evidence of a 'diplochordate' condition in which there are two 'pleurochords'.

It has been pointed out (Graham Kerr) that the specialization of cells by vacuolation for supporting structures is not confined to vertebrates, but is found in the lower groups, as for instance in the endodermal vacuolated cells of the tentacles of *Hydrozoa*. The endodermal cells of the enteric cavity of *Hydra* are markedly vacuolated and may serve as a supporting structure for respiratory or other purposes.

With these facts in view, and admitting the possibility of changes in the notochord by degeneration, change of function, or specialization, we may consider the evidence afforded by this new form on the question of structure variously called notochord (Bateson), stomochord (Willey), 'Eicheldarm' (Spengel), or 'Blindsack' (Hertwig).

In most *Enteropneusta* there are two places in the body where there is an approach to the condition of a central lumen completely surrounded by vacuolated cells such as occurs in *Hydra*, (1) the region of the body immediately posterior to the stomochord. The radial symmetry of these vacuolated

cells is interrupted by their greater concentration on the dorsal side, and by the prolongation of the skeletal limbs into this region. In *Ptychodera capensis*, however, the skeletal limbs are not lodged in the sides of the oesophagus but project freely into its cavity accompanied by a strip of vacuolated cells apparently homologous with the parachords, and the circle of vacuolated cells is complete. (2) At another place in Enteropneusta, namely, in the region of the proboscis, there is a central lumen surrounded by vacuolated cells, forming the stomochord or proboscis enteron or 'Eicheldarm' of Spengel. As in the collar region it has on its dorsal aspect a blood-sinus (the 'heart'), surrounded by a definite space (the 'pericardium'). The presence also of two excretory tubes in the proboscis increases the resemblance to the collar region, and the concentration of vacuolated cells on the dorsal and ventral aspect at the anterior and posterior ends (figs. 1-3, Pl. 42) is not without analogy in more posterior parts of the alimentary canal. It is doubtful, therefore, whether this region represents a notochord or a reduced enteric cavity of a pre-collar segment.

Posterior to the proboscis region the stomochord in *Xenopleura* undergoes a change. The external vacuolations disappear and the central lumen is surrounded by a simple layer of non-vacuolated cells, recalling the 'Nebendarm' described by Spengel in more posterior regions of the body in some Enteropneusta (fig. 4, *not.*, Pl. 42).

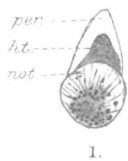
In the following sections a further change occurs, vacuolation appears in the lumen, which finally disappears; the arrangement of vacuolated cells is then more like that in the notochord of vertebrates than in the proboscis region. Moreover, we have here an organ which agrees with the definition of a vertebrate notochord as given above. It may, however, be said that, as the solid structure is a continuation of the proboscis part, it is open to the same suspicion that it represents a closed part of the enteric canal, and is not like a typical notochord derived from a groove or thickening of the dorsal aspect of the primitive enteron. The objection, however, does not apply to the collar

and branchial region posterior to the stomochord, where, as we have seen, there is, in *Xenopleura*, a definite dorsal tract of vacuolated cells, differentiated from the rest of the enteric epithelium, and apparently homologous with the notochord of the vertebrate type, though not definitely cut off from the alimentary tract as is the case in the later stages of development of the organ in vertebrates.

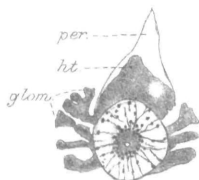
EXPLANATION OF PLATES 42 AND 43.

Figs. 1-10 are enlarged 160 times; figs. 11-14, 60 times.

bl., blood-vessel; *c.oe.*, non-vacuolated cells of oesophagus; *em.*, embryo; *ep.*, epithelium of body; *ep.b.*, epibranchial band; *et.*, excretory tube; *et'*, external opening of excretory tube; *et''*, internal opening of excretory tube; *ft.*, foot or ventral fusion of lateral folds of body; *g.*, gill-pouch; *g'*, external opening of gill; *g''*, internal opening of gill; *h.*, heart; *l.f.*, lateral fold; *l.not.*, lumen of notochord; *m.*, muscles; *med.f.*, medullary folds; *n.*, nerve-cells; *n'*, nerve-fibres; *not.*, notochord; *oe.*, oesophagus; *oe'*, branchial part of oesophagus; *par.*, parachord; *p.*, pericardium; *per.s.*, periaemal space; *pl.*, pleura; *post.n.*, posterior neuropore; *sk.*, skeleton; *sk'*, branchial bars; *sk''*, homogeneous substance; *v.c.*, vacuolated cells; *v.s.*, ventral septum.



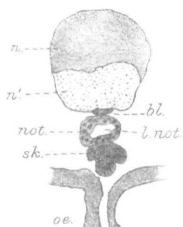
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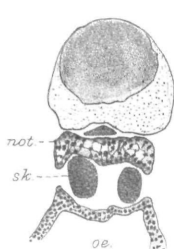
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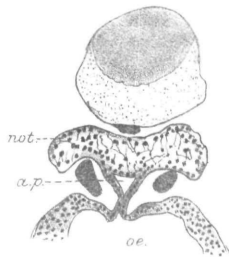
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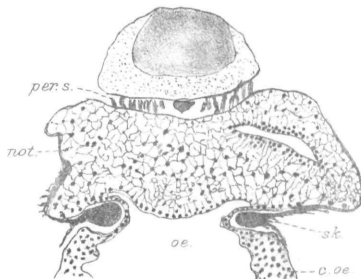
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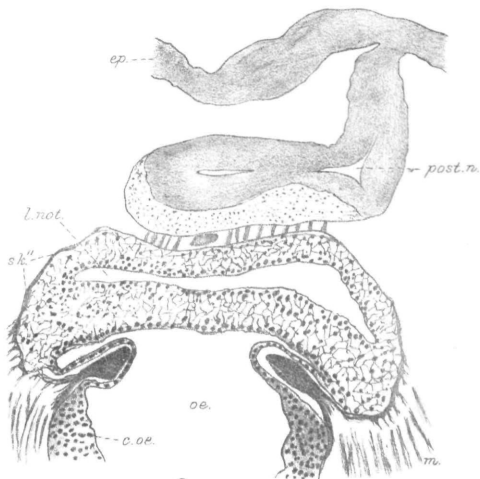
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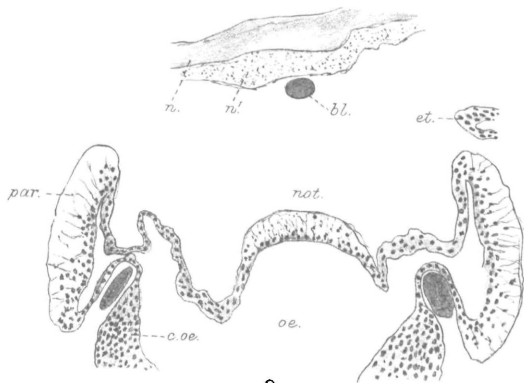
6.



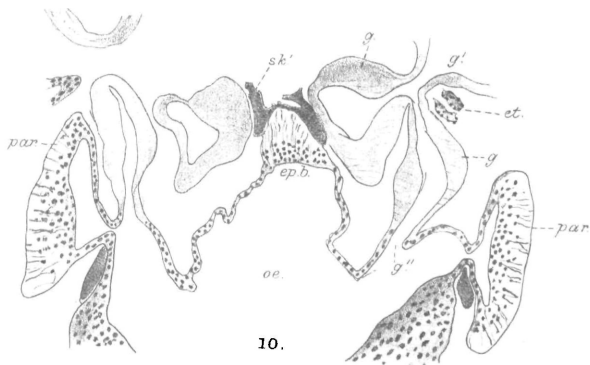
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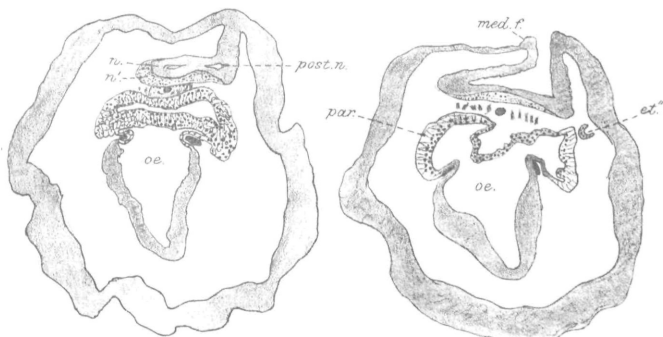
8.



9.



10.



11.

12.

