Some Stages in the Development of the Thyroid Gland in Petromyzon.

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STRUCTURE AND DEVELOPMENT OF THE THYROID GLAND IN PETROMYZON.

[illegible].

[illegible] work was done [illegible] species. The first species was P. planeri [illegible], which, in the adult condition, reaches a length of [illegible]. The first lot of material was collected [illegible] Naples. It included stages from [illegible] to the swimming larva in which the eye was [illegible] visible and in which the mouth was separated from the gut only by a thin partition of cells. This [illegible] was killed fourteen days after fertilization.

The second lot of material was obtained at Ithaca, N. Y., [illegible] of Petromyzon fluviatilis, Wilder (Lake lamprey) and P. [illegible] (Brook lamprey), as both species are known to spawn in the same nest and it is impossible to tell to which species the larvæ belong. Part of this lot of material was sent me through the courtesy of Prof. S. H. Gage of Cornell; the rest I myself obtained from one of the "nests" in a stream at Ithaca, New York.

[illegible] to my friend [illegible] material [illegible] made out: [illegible] amount of [illegible], wholly un- [illegible] worn: and to [illegible] sections during [illegible].

[illegible] killing in [illegible] and 5c.c. [illegible] and staining, [illegible] with Lyons blue. [illegible] was in obtaining [illegible]. Embryos [illegible] case was a good [illegible] was tried [illegible] was experienced also in sectioning [illegible] amount of the mass of yolk, [illegible] of this kind.

[illegible] though in most cases the [illegible] series of sections.

Development of the gill-slits in Petromyzon.

[illegible], in Petromyzon, as [illegible] ventral wall of [illegible] called the pha- [illegible] gill openings connecting [illegible].

[illegible], the first found, in [illegible] P. [illegible], [illegible] the slightly older, that is to say [illegible] tion.

[illegible] is seen in Fig. 1 [illegible]. [illegible] indication of gill-slits, [illegible] not broken through, [illegible] solid mass at the point [illegible]. In the figure, the entoderm [illegible] cells forming the [illegible] is represented [illegible]. The stomodæum is seen [illegible], in a slightly older stage, the [illegible] is seen as a series of shallow [illegible] part of the neck of the flask.

The thyroid gland, [illegible] end, is broad and deep, so that, with its thick walls, it is half as large, in cross section, as the part of the pharynx from which it is de-

[illegible]ives. The lateral walls are, throughout the length, very thick, and are composed of [illegible] rows of growth, elongated cells, each cell with a large [illegible] near the center. The ventral wall is [illegible] composed of shorter, even [illegible] cells.

[illegible] deeply, it is found to become [illegible] allow until it finally [illegible]

[illegible] older stage, [illegible] through the mid- [illegible] appearance as an evagination [illegible] (phar.). The thick lateral walls [illegible] thyroid are shown in this [illegible] figure [illegible] while, while posterior to this [illegible] gradually becomes [illegible] appears.

[illegible], is a groove, relatively [illegible], and opening along the ventral [illegible]

(10th day.) On the tenth day the thyroid begins to be shut off from the pharynx by the growth of two horizontal partitions, one roofing over the anterior end, the other roofing over the posterior end, of the thyroid groove.

[illegible] shown at a slightly
[illegible] section through the
[illegible] by the thyroid al-
[illegible] of the medial
[illegible] (a. h. l.)
is [illegible] lobe, which is
[illegible] wall of the thyroid
[illegible] upon the remaining
[illegible] represented in
Fig. [illegible] plane is shown
[illegible] of the groove.
[illegible]. The body wall of
[illegible]), [illegible] first indication
[illegible] divisions of the pha-
[illegible] .c.). A transverse
[illegible] anterior end of the
[illegible]) and that it is now
[illegible] , [illegible] while, within just beneath
[illegible] cells. Throughout
[illegible] which [illegible] numerous
[illegible] , [illegible] ingrowing
[illegible] will be [illegible] later
stages. The cells [illegible] pharynx are not so sharply differentiated from those on the roof of the thyroid as is

in [illegible] Fig. [illegible]. The cells of the body wall are very thin [illegible] lining this part of the pharynx. [illegible] posterior to Fig. 1 b., [illegible] passes through the part [illegible] to the pharynx. In Fig. [illegible] are dotted, while in Fig. [illegible] c. [illegible] the pharynx are dotted. Th[illegible] is the beginning [illegible] the thyroid being [illegible] growth of the ante-[illegible]

The se[illegible] rapid growth at the points whe[illegible] posterior epithelial [illegible] pharynx, causing these two [illegible] layer of each [illegible] pharyngeal epithelium, [illegible] epithelium of the thyroid (Fig. [illegible]). [illegible] ly, it still [illegible] length. As is seen in Fig. [illegible] closely pressed [illegible] but it is difficult [illegible].

It will [illegible] compare the thyroid of Petromyzon at this stage with the thyroid, at a corresponding stage, in Amblystoma (Figs. 9 a and 9 b). A section through the

...Petromyzon... thyroid (Fig. 1 ...) shows it ... still an open ... ...). ... hand, the open ... of the gland, the closing ... direction.

... the lateral ... ior end, ... of the co- ... same time an ... a longitudinal ... lls of the gland ... ...ll more marked ... direction.

... ion end of the thyroid ... ion would show ... and ventral walls ... in a wax re- ... sections of ... ...n end of the gland ... ...ellant. The two ... by the mesoblast ... ...ge the sepa- ... ...nterior end of the gland. The thyroid is here not so closely pressed against

the pharynx [illegible] the case in previous sections, being separated from the wall of the pharynx by a collection of mesoblast cells. The [illegible] wall of the gland is crescentic in cross section, [illegible] with the [illegible] beginning of the lateral [illegible].

[illegible] for about 2/5 of its [illegible], [illegible] widely, so that its opening [illegible] extending only 1/[illegible].

[illegible] to this opening (Fig. [illegible]) [illegible] portion of the anterior end, [illegible] complicated by the thickening of [illegible], a slight, circular cavity of the [illegible] Fig. 3 b.) [illegible] by the growth and [illegible] of [illegible], to a narrow vertical slit with lateral [illegible] bounding the cavity, in cross section, [illegible] the form of a letter T. The dorsal wall of this cavity (Fig. 3 b, d.l.) is comparatively thin, being composed of a single [illegible] short columnar cells, and is what Dohrn calls the "Deckplatte." The ventral wall is also comparatively thin, [illegible] for the center, at the extreme anterior end of the unpaired cavity, a slight upward projection (Fig. 3 b, m.l.) which would seem to be the first indication of the medial longitudinal partition that will later divide the gland into two lateral parts. According to Dohrn, this me-

dial lamella is formed as far back as the opening of the gland, before the lateral invagination takes place, but in my material this is certainly not the case, as is shown in Fig. 2 b.

The lateral invaginations extend posteriorly to a point a little behind the anterior edge of the slit-like opening into the pharynx. The figure shows a section that cut through the extreme posterior part of the invagination in the right side but was too far posteriorly to cut that of the left side, either because the section was somewhat oblique or because the right invagination had proceeded further than the left.

It is well to get a clear idea of these lateral invaginations in the simple condition represented in Fig. 2 b, as the more complicated later stages will then be more easily understood. If the lateral walls should grow out, thus obliterating the lateral invaginations, the thyroid would be reduced to a more or less solid gland body, as it was in Fig. 1 b, though with a much larger cavity. The lateral walls of the lateral walls are divided by the invagination into two groups, which become more and more distinct as development proceeds. In Fig. 2 b one of these groups, on each side, lies between the invagination and the perpendicular part of the cavity of the gland; the other group lies between the invagination and the dorsal, horizontal part of the cavity. (Compare Fig. 3 e.) The cavity of the thyroid between this point and the posterior edge of the opening into the pharynx is simply a deep and narrow groove, slightly

[illegible] narrow space is left, on either
[illegible] ventral walls (Fig. 8d).
[illegible] walls of the
[illegible] another, and
[illegible] from the
[illegible] thyroid pos-
[illegible] structure, nearly
[illegible] cavity
[illegible] thickness
[illegible] of the
[illegible] color; in fact,
[illegible] this is the case.
[illegible] length lies a
[illegible]" of Dohrn).
[illegible] grooves, "Pseudo-
[illegible]

[illegible] were obtained
from the T[illegible], and the larvae
[illegible] as remembered, were
[illegible] identical with
those from [illegible]

[illegible] thyroid gland
is [illegible] (Fig. 4 a,
m.e.) which is [illegible] in dorsal
and ventral walls, beginning at the anterior end and gradually
extending posteriorly until, at this stage, the gland is separated

into two distinct lateral parts, from the anterior end about half way to the opening into the pharynx. Fig. 4 c is a section [illegible] the dorsal and ventral partition, showing the division into a dorsal and ventral cells. The once simple tube is now [illegible] the form of its walls. The [illegible] "lateral invaginations" (l.i.), [illegible] the dorso-median direction, [illegible] as seen in Fig. 3 b. The [illegible] roof and floor of the gland [illegible] fuse, thus separating [illegible] halves. At a later stage [illegible] between these halves so [illegible] stage the mesothelial [illegible] cells, and containing [illegible]. At this time also [illegible] ("Pseudobranchialdrüse") [illegible] appears in the floor of the gland [illegible] distance from the opening of the gland (Fig. [illegible]). In this stage no cilia could be seen, [illegible] it was at later stages of development. The gland, in the region represented in Fig. [illegible], in cross section, its resemblance to the letter T. This section is anterior to the duct, but posterior to the median lamella represented in Fig. 4 a. The other changes noticed at this stage are :- the closing of the

small circular
represented);
Dorm, the
thickening
"Lamellello")
to what we
loading stage

one mm. long,
normal Amphio-
e of the head
oscope with a
d are accu-
first to the
the pharynx
ends did not
upward
not loading
is illustra-
that in the
ter, while
ite,
ling very
e is quite
transparent, so that the pallium of the head and the velum

(v.), and the circulation of the blood through the branchial arches can be seen readily under a low power. The thyroid, which [illegible] of the animal, shows very plainly [illegible] of the pharynx [illegible] broad dotted [illegible] over the mouth [illegible] (e.), no attempt [illegible] organs of the larva.

[illegible] of this eye shows the thy- [illegible] against the ver- [illegible]

[illegible] made in the le- [illegible] veloped [illegible] tal grooves. Fig. 5 b [illegible] dor to the thyroid. [illegible] (th.), body wall (b.w.), [illegible] of the pharynx (phar.) [illegible] le, passes through the ciliated groove [illegible] anteriorly-direct- ed, ventral [illegible] ward to run [illegible], to the left). On the [illegible] grooves are distinct as a thyroid (th.g.) and [illegible] (h.p.g.) grooves. These grooves are lined with cells which are much higher and more columnar than the cells of the rest of the pharyngeal wall, so that they are easily followed, by sections, throughout their course.

Their cilia [illegible] distinct.

[illegible] roid and pha-

[illegible] stages, being

[illegible] closely packed,

[illegible]. The outline

[illegible] magmatic manner,

[illegible] under a camera.

[illegible] of the dorsal and

[illegible] the two dorsal

[illegible] -dorsal line

[illegible] are seen to approach

[illegible] lls of the pha-

[illegible] pproach each

[illegible] until they are

[illegible] lower cells

([illegible] to the thyroid

[illegible] ce posteriorly,

[illegible] l ridge

([illegible] xtreme poste-

[illegible] of which it

[illegible].

[illegible] pproach the

mid-[illegible] unite and load

into the [illegible] (Figs. 1-4). Just [illegible] to the

cy ning into th- ti id 'h , are continue on th floor of the
[illegible] a ridgle, a fillow, a liar narv. (Figs. 5 j-k),
which [illegible] a groove, [illegible] of thickened epithe-
lium. [illegible] may be
[illegible] grooves may be
[illegible] plainly with a
lens, [illegible] ring from the dor-
sal [illegible] be made out.
[illegible] sections showed the
[illegible] arrangement could
[illegible] grooves is quite
[illegible] interesting book
"[illegible]." On page 183
[illegible] ries in front of
[illegible] first gill-pouches),
[illegible] dorsal midule
line of the [illegible] of the oesoph-
agus. [illegible], and uniting
posteriorly, [illegible] move to the pos-
terior lip [illegible]."

[illegible] grooves
then is briefly as follows:- On the floor of the pharynx, begin-
ning at or near the opening of the oesophagus, is a ridge of
epithelium on which no cilia could be made out. This ridge,

after extending forward for a very short distance, becomes changed gradually into a shallow, median, ciliated groove that continues [illegible] of the thyroid. Just anterior to the [illegible] divides into two [illegible] of the pharynx, [illegible] on each side [illegible] grooves then converge [illegible] median to the front end [illegible] the median, cili-[illegible], [illegible] the oesophagus, [illegible] ventral wall.

[illegible] previous [illegible] The lower cells [illegible] until they now [illegible] (Figs. 5 f-m, f.l.) have [illegible] now lie near one end. [illegible] the median lamella (Figs. 5 e-f, m.l.) [illegible] look as the dot. From the [illegible] (Figs. 5 i-k, m.l.) The lamella [illegible] floor of the slit but [illegible] being swollen [illegible] (Figs. 5 i-k, m.l.). The lateral lamella [illegible] and important in determining the structure of the organ. Near the anterior end (Fig. 5 e, l.v.) it has not changed greatly from the condition

in which it was at [illegible] stage, but as we pass to sections farther back we find the invagination forms a considerable cavity (Figs. 5 f-h, i.v.), and part of the [illegible] section, is seen to be divided into a ventral and two lateral divisions. [illegible] part of the invagination [illegible] (Fig. 5 i, mes.).

The [illegible] ridges that have taken place [illegible]. The first among the changes [illegible] of these cells into two groups, [illegible] cells proper. The [illegible] in Fig. 5 e. As a result [illegible] cells appear to have migrated [illegible] somewhat oval mass of cells [illegible] point, by the lateral [illegible] of this oval mass of cells, [illegible] cells (m.l.), is seen [illegible] (n.g.l.) apparently having been [illegible] (n.g.l.). The nuclei in the middle [illegible] short columnar cells (Fig. 5 f, n.l., [illegible] in the gland cells proper (Fig. 5 f, g., [illegible]). A considerable space is formed between the ciliated cells and the gland cells, which becomes connected with the lateral invagination (Figs. 5 f-h, i.v.) by the separation, in the centre (at the end of the line n.g.l., Fig. 5e)

of the nuclei of the lateral row (n.gl.) and the joining of these separated cells with the nuclei of the adjacent sides of the transitory, fluid [illegible] cells above (dorsal to) the [illegible] (n.gl.) and the [illegible] above the investing [illegible] (v.l. and ventral to) n.gl. joining the cells [illegible] invagination. In other words, the [illegible] cells and the [illegible] exterior by the breaking [illegible] the end of the [illegible] invagination. [illegible] lines, referred to above, [illegible] cells.

[illegible] the formation [illegible] (f.l., s f, f.l.), but also [illegible] cells in each half of the [illegible] like, two are larger [illegible] invagination at this stage (f.l., s f-j, g.f'.) and still [illegible] when fully developed [illegible] first formed groups. [illegible] somewhat fan-shaped, when seen in optical [illegible] elongated conical cells, which [illegible] at their bases.

On account of the great difficulty in obtaining good preparations of these gland cells, as before mentioned, many series

of sections [illegible] to be studied before any conclusion could be reached as to the minute structure of the cell groups. The pointed ends of the cells are directed towards the [illegible] (o.) of the cell [illegible], are usually [illegible] and the [illegible] appear there as [illegible] cells. Practically every instance [illegible] the staining of the cell group. This [illegible] proved to be a small area [illegible] the cell group by the [illegible]. There was no section [illegible] fact could be [illegible] was carried over, as [illegible] seen in Fig. 1 (a cell [illegible] magnified [illegible] is covered over by a [illegible] line from which the cells radiate. The group, may be followed [illegible] sections, and the [illegible] each section, it is difficult to [illegible] the outer side of the cell [illegible] bodies of cells in the [illegible], that diameter [illegible] resolution, are too minute to be seen, [illegible] magnification of 1200 diameters.

In Fig. 1 may be seen, just under the basement mem-

[illegible], a number of triangular condensations of the cell substance on each side of the epithelium. These elongated cones were seen [illegible] of which appeared to be stained in [illegible] while presence suggested [illegible].

[illegible] gland may be considered [illegible] and two small cylinders [illegible] the whole length of [illegible]. The small cylinders (s.c.) [illegible] scarcely be recognized [illegible] will acquire later [illegible] larger cylinders (l. [illegible] cylinder or [illegible] mentioned above (Fig. 1 f, [illegible] the secretion of the [illegible] and thence, through [illegible] pharynx.

[illegible] gland may be [illegible] is somewhat complicated [illegible] tubular branches of the oblique [illegible] of the pharynx, retain clearer and smaller [illegible] and form a single [illegible] (Fig. [illegible], t.c.m.). In Fig. 1 f the ventral ciliated grooves (v.c.g.) have almost united, being separated only by a wedge-shaped portion of the pharyngeal floor.

They are long and so narrow that there would seem to be but little room [illegible] filling the grooves are [illegible] of the pharynx, [illegible] to be the only [illegible]

[illegible] one side only, [illegible] three fourths [illegible] cells (d.l.) [illegible] on the other. The [illegible] they from a [illegible] apart. The [illegible] form, and are [illegible] that has been described [illegible] sal ends to the [illegible] junction (i.v.). [illegible] by the angular [illegible], lying close [illegible] cells. Before reaching the [illegible] groove [illegible] resembles, in cross section, an [illegible] of the T turn [illegible] (Fig. 2 h, i.) until they are closed [illegible] by the [illegible] of the T. The way in which this curious groove opens, finally, into the thyroid is interesting. A short distance back of the point represented

[illegible] Fig. [illegible] h, the cells of the ciliated [illegible] layers are in-
[illegible] and at the
[illegible] (m.g.) becomes
[illegible] (Fig. 5 h).
[illegible] ciliated layer
[illegible] and at the
[illegible], we have
[illegible] of the cover
[illegible] of the gland
[illegible] (m.l., Fig. 5 i)
[illegible] and 5 i,
[illegible].
[illegible] section pas-
[illegible] see that the
[illegible] passes out
[illegible] ulation group
[illegible] and thence
[illegible] secretion from
the [illegible] through the
[illegible] canal chambers
(m.c.c. and l.c.c., [illegible]). The secretion
from the [illegible] pass out either
way. The duct is [illegible] in a postero-ventral direc-
tion and is lined with ciliated columnar cells. The point at
the end of the line 1 (Fig. 5 i) indicates the place of union of

of the medial part (Fig. 4 h, l) of the ciliated layer with the adjacent side (l') of the deep, ciliated groove (v.c.g.). Reference line [illegible] the dorsal part (3) of the ciliated layer (l.). [illegible] the union of the medial portion (2) [illegible] of the two parts of the [illegible] complete partition all the way [illegible]

[illegible] the medial portion (2) [illegible] the opposite side, [illegible] part (3) of this layer [illegible] of the cover layer. [illegible] (l.v.) apparently [illegible] part of the gland, [illegible] mesoblast cells are found [illegible] (mes.) [illegible] is shown also in Fig. 3 m, [illegible] the entire gland. A section [illegible] has the lateral invagination (l.v.) [illegible] the lateral from the central portion of the gland, but of course if the section were cut nearer to the dorsal surface of the gland, the lateral portion would be seen to be joined to the central portion anterior to the duct (to the left of m.l.), as has been seen in

Figs. [illegible]. Fig. [illegible] shows the extent to which the gland is completely divided by the partition (m.l.), and also the position of the [illegible] with [illegible] (v.c., 2-5). The cilia are omitted in the figure. In all the sections posterior to this, [illegible] three distinct ciliated chambers. The [illegible] (m.c.h.), occupying the [illegible] is [illegible] in cross section, and its [illegible] the median lamella (m.l.) [illegible] wall. Into each half of [illegible] one of the large [illegible] cells. The smaller cell [illegible] is still in a [illegible].

The [illegible] (m.c.h.) is crescentic in cross section, its [illegible] being formed by the ciliated cells, its [illegible] by the cover cells. Into the lateral [illegible] a large [illegible] small group of gland cells. Dorsal to the [illegible] the large blood vessels (art.) and close above these the floor of the [illegible], with the ventral ciliated groove (v.c.g.), [illegible] finished in depth. Fig. [illegible] is of a section near the posterior end of the gland, passing through the upturned portion. The reference line m.c.h. begins in the cavity of this upwardly bent part, which is cut through at the point where it is continuous with the central ciliated chamber of the gland. A section just anterior to this

would show this upper space [illegible] cavity. Dohrn says this marked [illegible] and, it will be the less marked [illegible] the growth of the gland [illegible] which it is enclosed.

[illegible] point represented [illegible] and partition (m.l.) is still [illegible] m.l'. In Fig. [illegible] g.) and dorsal ridge (d.r.) [illegible] Fig. 5 k. The blood vessels [illegible] with large, nucleated [illegible] Figs. 5 k and [illegible]), [illegible] arrangement of the gland cells [illegible] no longer. The [illegible] nearly circular cavity, and the [illegible] opening out gradually, [illegible] mentioned in the description [illegible] The ciliated dorsal ridge [illegible] folds. The cell [illegible] end of most of the pharyngeal cells [illegible] most of the preceding figures.

In the following and last stage of development (Figs. 6 a-k), the gland has apparently reached its greatest complexity,

[illegible] noticeable [illegible] the [illegible] and much [illegible] stage, [illegible] the [illegible] coiling of the [illegible] has been previously [illegible] of the gland being [illegible] enclosed. The [illegible] length of [illegible] cm. in the region of [illegible].

[illegible] of a larva [illegible] of which has [illegible] to each [illegible]. The figure shows the [illegible] sides, and also its relation [illegible] bars (c.b.) of the branchial [illegible] it is seen that the large mid-ventral [illegible] the posterior end of the gland, [illegible] which lies close [illegible] entire length of the gland. The [illegible] and lateral invaginations) are [illegible] mass of white, fibrous-looking [illegible] the gland on all sides. At this stage, as in Fig. 4, the gland extends from the middle of the first to the middle of the fourth gill pouch (g.p.) and is about 1/3 the diameter of the entire pharynx.

In a ventral view, the coil of the posterior end of the gland does not, of course, show, but on each end is seen a median process [illegible] the fibrous envelope; these processes [illegible] parts of the gland, and [illegible] most of their length [illegible]. The numerous [illegible] are seen in this [illegible] of the anterior wall [illegible] shown.

[illegible] of the gland, [illegible] out, and also [illegible] size and position [illegible] reconstructed and [illegible] more or less accuracy [illegible] a little [illegible] the gland, though [illegible] straightened out, [illegible] anterior end.

[illegible] it will be noticed [illegible] of a nearly circular [illegible] apparently not having [illegible]. This represents the actual relative longitudinal [illegible] dimensions of the duct. The actual increase in size of the gland may be appreciated by noting that, though all the sections were drawn with a camera,

those represented in Figs. [illegible] are enlarged 240 diameters, while those in Figs. [illegible] are magnified only 30 times.

[illegible] the posterior end of the gland, passing through the [illegible], 1 t, is represented in Fig. [illegible] of size, between this and the preceding stage (Fig. [illegible]) the cell-groups (cg', [illegible]) are smaller and unisexual, which is exactly [illegible] cells, the groups lying near the [illegible] Figs. 3 e and k, [illegible] cell-groups into [illegible] and for convenience "dorsal" and "lateral" poles of cell-groups, [illegible] groups gr', never reach [illegible]

[illegible] since the preceding, [illegible] as well as actually, [illegible] established layer, while [illegible] partly filled with [illegible] The nuclei of the longer cells are small and circular in outline, and no definite planes seem to be more or less regularly arranged near one end or other of

[illegible] cells, while at other places there is no apparent regularity [illegible] in arrangement. In Fig. [illegible], the cells with large nuclei are shown on either side of the slit-like openings (o.) into the cavity of [illegible] cells. The bilobed grooves (v.c.g.), on the [illegible] are [illegible] distance apart [illegible] [illegible] changed from their [illegible] [illegible]. They are separated by one layer [illegible] [illegible] of the pharynx, which [illegible], [illegible] [illegible] in outline, probably [illegible] [illegible]. They are very deep and [illegible] [illegible] their cilia.

[illegible] (t.c.) of the thyroid, spoken of [illegible] [illegible] presence of the thyroid is seen, [illegible] [illegible], around the gland, and [illegible] [illegible] lamella (m.l.). It also [illegible] [illegible] of the large cells [illegible] [illegible] (Spritz-lochermasse) (s.m.). [illegible], [illegible] enclosed space (i.v.), [illegible] "[illegible] imagination", is more [illegible] filled [illegible] of [illegible] tissue with [illegible]. [illegible] also fills the space between [illegible] and [illegible] thyroid. Numerous small blood vessels are found imbedded in it, both in that which fills the lateral invagination and in that which lies between the gland and the pharynx. This tissue is represented only in

Figs. [illegible] but the fibrous tissue is shown in all the figures [illegible].

[illegible] a short distance [illegible], and about corresponding [illegible] ciliated grooves [illegible] groove which is [illegible] (g.) described [illegible] cells of cell- [illegible] adjacent groups [illegible] the ciliated [illegible], in its dorso- [illegible] Fig. 5 a), its cells [illegible], round nuclei [illegible] the large oval [illegible] the openings (o.) [illegible] group of cells, [illegible] latter, that [illegible] lies posterior- [illegible] ciliated groove in the [illegible] shown in Figs. 5 h-i [illegible] discussion. [illegible] increased in [illegible] the shrinkage of the connective tissue (c.t.) surrounding the gland. There is considerable space at this point between the pharynx and the

[illegible] which resembles the very deep ciliated groove shown [illegible] the next figure, [illegible] (b.t.) be very large [illegible] connective tissue men- [illegible] sections is re- [illegible] difficult to dis- [illegible] closely [illegible]

[illegible] ending of the [illegible] duct, a [illegible] columnar cells, [illegible] spoken of [illegible] the long cells [illegible]

[illegible] is now entire- [illegible] pocket (g.) [illegible] the duct, [illegible] posterior end [illegible] taking no [illegible] is for some [illegible]

[illegible] is point [illegible] from this point, [illegible] projecting upwards into the median ciliated chamber (m.c.c.) and covered by the cover cells (d.l.) (Decklamelle) of the two median pairs of cell-

[illegible] this ridge is [illegible].

[illegible] end of the coil and the [illegible] through the [illegible] from a cor- [illegible]) except in [illegible] end of the [illegible]) is long and [illegible] part is made [illegible] lateral ciliated [illegible] in the preced- [illegible] above the gland [illegible] than it was [illegible] condition [illegible] gland. [illegible] and the [illegible] reticulated [illegible] b.

[illegible]) all pass [illegible] the points [illegible]. The appar- ent complexity [illegible] plain by com- paring them with the diagrammatic lateral view of the gland (Fig. [illegible]). In all four sections, what we have called the lat- eral pairs of cell-groups (l.c.g.) remain the same and may be

recognized by their long, curved, lateral ciliated chambers (l.c.h.').

In Fig. [illegible] the primary cell-groups are seen in a mid-ventral position [illegible] followed in an anterior-ventral [illegible] ventral position (m.c.g'.), [illegible] posterior direction, [illegible] m.c.g''. as they [illegible] This is easil, [illegible] in Fig. 6 k, [illegible] where the poste-[illegible] cell-groups (m.c.g'.) [illegible] anterior (m.c.g''.). [illegible], is this sec-[illegible], to the middle (m.c. [illegible] The general char-[illegible] remains about [illegible] is will be only [illegible] ent in the sec-tions.

[illegible] cell-groups [illegible], m.c.g. in the [illegible] m.c.g'. In the dorsal, [illegible] m.c.g''. In the part that is di-rected again towards the posterior end, and at m.c.g'''. in the last whorl of the coil which is directed towards the anterior

end of the gland. It will be noticed in this and in the other sections [illegible] of the gland, that the [illegible] only a short distance. The [illegible] part of the coil [illegible] the posterior-[illegible] never found in this end of [illegible] caused out by some [illegible] median cili-ated [illegible] whorls of the coil [illegible] ventral position, [illegible] dilated chamber [illegible] is divided by the median [illegible] (m.c.g'.) It is [illegible] coil. In the middle [illegible] numbered m.c.g'''., [illegible] pressure of the [illegible] that the glands [illegible] comparison with the [illegible] that the gland is, in [illegible] further forward. [illegible]

[illegible] point where the [illegible] whorl (m.c.g''.) turns dorsal-ward to pass anteriorly as the innermost whorl (m.c.g'''.) of the coil.

Fig. [illegible] shows two [illegible] of the four sections [illegible] point where the [illegible] dorsalward [illegible] directed whorl [illegible]

[illegible] cell-groups [illegible] stand for a con- [illegible] diminished [illegible] they are in close [illegible]

[illegible] point about [illegible] and the [illegible] fibre of lat- [illegible] ventrally curved [illegible] so the cell [illegible] seen on each [illegible] Figs. 4 a-h, [illegible] Fig. 3 i,art. [illegible] ve above. [illegible] cross section [illegible] pharynx [illegible] coiled end of the gland and sinks down again just behind this elevation. The groups of gland cells have diminished somewhat in cross section, but they

are not greatly flattened at their anterior end.

The [illegible] build [illegible] ster end [illegible] growth being [illegible] to [illegible] the coil, [illegible] distance [illegible]

lampre.

lampre,

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, Pl. VII)

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of part of the

thyroid.

just trans-

l maturity,

it is

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and a mere

rudiment in the

older animals. As is seen in Fig. 19 a, the thyroid, which in

the younger larval stages was enormously large, proportionally,

is a small [illegible] follicles lined with columnar or cuboidal epithelium [illegible]). [illegible] by connective tissue [illegible] median ventral [illegible] on either side. [illegible] the 4th gill [illegible] location [illegible] cells, [illegible] four to six [illegible]

[illegible] the salivary [illegible] taken the [illegible] for the tissue [illegible] the cavity.

[illegible] has just [illegible] half of the [illegible] in the floor of [illegible] used by the animal [illegible] of this muscle [illegible] action thus [illegible]

[illegible] of the [illegible] lying in the [illegible] basilar muscle. In the much smaller brook lamprey, the position and structure of the basilar gland may be made out by stained serial sections

(Figs. [illegible] b). Each fold of the gland is a thin walled
ovoid [illegible] In cross section, in the
[illegible] of a short
[illegible] irregular-
[illegible] of gland into the
[illegible]

[illegible] distance
[illegible] forward, grad-
[illegible] never
[illegible] a small papil-
la. [illegible] The posterior
[illegible] only a dis-
[illegible]

[illegible] a section through the
[illegible]. The large
[illegible] between the body
wall [illegible] Embedded in
[illegible] (t.g.) whose walls
[illegible] has been men-
tioned.

[illegible] under greater
magnification. [illegible] the section
passes through a fold similar to the one at the duct (d.)
into the gland. This figure shows that the folds in the wall of
the gland are formed by invaginations, of irregular form and at

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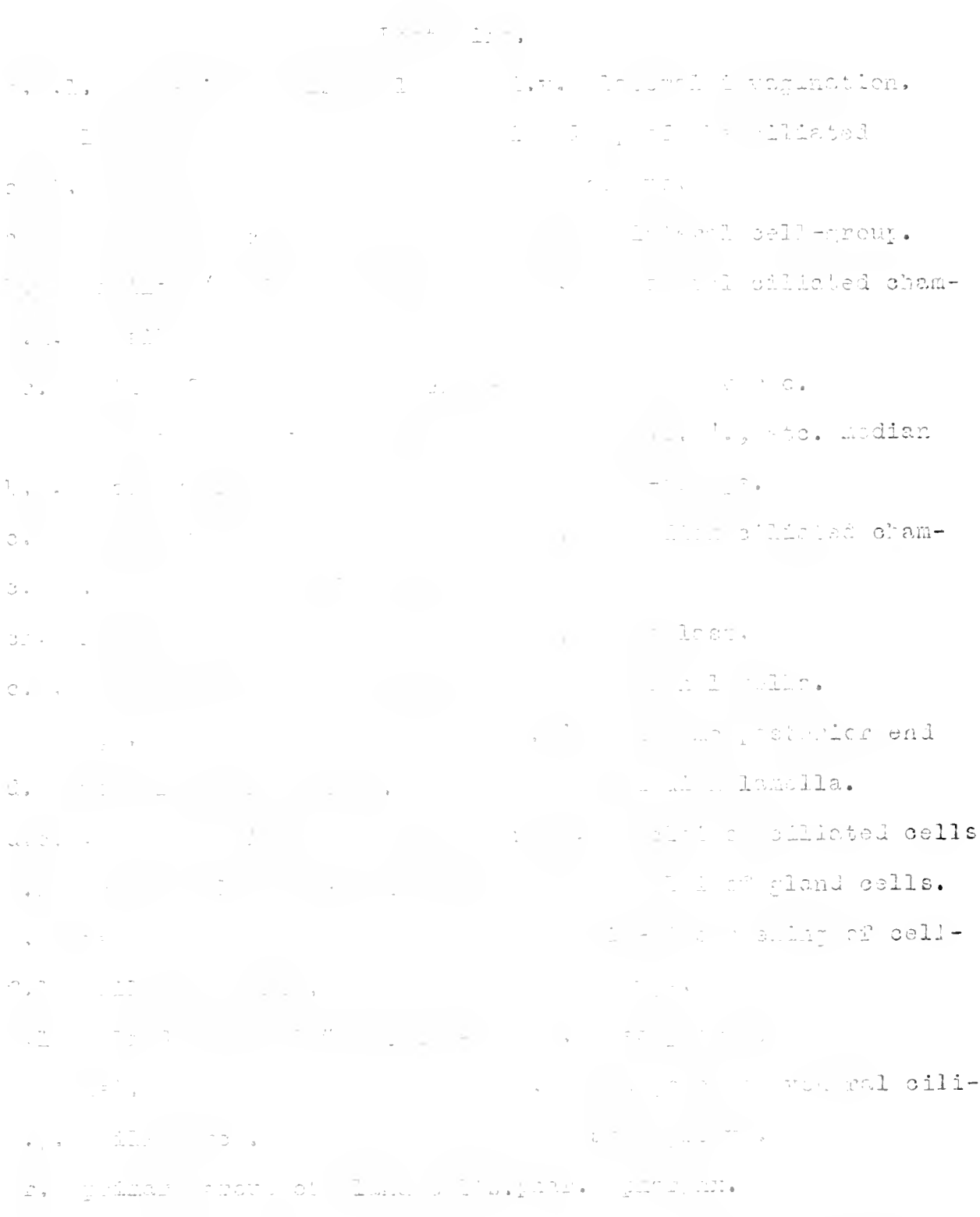
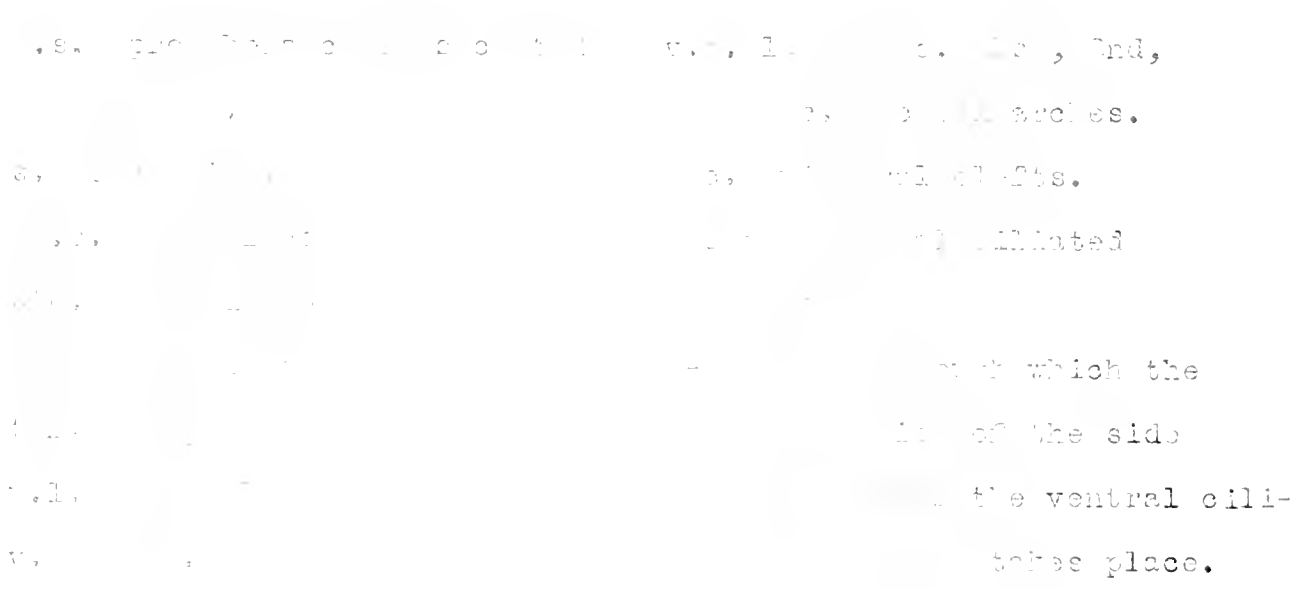


p.h.l. posterior horizontal lamella.



Explanation of Plate.

[illegible] Plate.

[illegible] verti-

[illegible] at the

[illegible] Mcl.)

[illegible] lure of P.

[illegible] anterior

[illegible] circular

[illegible] ctive

ovi[illegible].

[illegible] to Fig. 1 b

[illegible] fold into

[illegible] extreme an-

[illegible] larva.

[illegible] to Fig. 2 a

[illegible] ler, ax.

[illegible] Mon.)

[illegible] Fig. 2 b

[illegible] fold into the

[illegible]

[illegible] Transv[illegible] s for [illegible] to Fig. 2 c

thro[illegible] the posterior part o[illegible] the opening of the gland in[illegible] the

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to Fig. 4 a,

showing the

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invagina-

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Fig. 4c. Lateral v[illegible] end of a 5 mm. larva,

to show the relative size of the thyroid gland, and its position

in relation to the gill arches, etc. (Drawn from the living animal at a magnification of 70 diam.).

The [illegible] head of a [illegible] of Fig. 1 [illegible]. The point [illegible] from the [illegible]. The section cuts [illegible] but some- [illegible] (Mag. 240 diam.)

[illegible] posterior [illegible] of the cili- [illegible] the pharynx, [illegible] for the ventral [illegible] diam.)

[illegible] Fig. 5 c [illegible] ciliated [illegible] a short distance [illegible] dorsal ridge. [illegible] (Mag. 240 diam.)

[illegible] anterior end [illegible] of the two ven- [illegible] a thin [illegible] very long, are splitting off from their nucleated ends the cells to form the ciliated layer and begin to show an arrangement into the four cell-groups.

The lateral invagination [illegible] halves into which [illegible]. (Fig. 340 [illegible].)

[illegible] Fig. 8 e. [illegible] layer of [illegible] cell-groups. The [illegible].)

[illegible] to Fig. 8 f but [illegible] have united [illegible] at the [illegible] an inverted [illegible] the same as [illegible].

[illegible] to Fig. 8 g and [illegible] stume of the [illegible] ciliated [illegible].

[illegible] opening of [illegible] dium cili- [illegible] nerve, [illegible] ciliated groove [illegible] ventral figure. [illegible] invagination, and this pouch [illegible] the posterior end, divide the gland into three distinct parts, a median

and two [illegible] arts, [illegible] is no longer a com-
[illegible] [illegible] is [illegible] on its dorsal edge.
([illegible])

[illegible] [illegible] distance poste-
[illegible] [illegible] groove is still
[illegible] (Mag. [illegible] diam.)

[illegible] [illegible] to Fig. 8 j
[illegible] [illegible]. Shows the now
[illegible] [illegible] of the gland,
[illegible] [illegible] pharynx.
([illegible])

[illegible] [illegible] the extreme pos-
[illegible] [illegible].

[illegible] [illegible] the thyroid,
[illegible] [illegible], the relative
[illegible] [illegible] diam.)

[illegible] [illegible] the anterior end
[illegible] [illegible]. All four groups of
[illegible] [illegible] increased great-
[illegible] [illegible] Figs. 8 a-m were magni-
[illegible] [illegible] Figs. 8 n-s were magnified
[illegible] [illegible] Fig. 8 e of the
[illegible].

Fig. 8 b. Transverse [illegible] posterior to Fig. 8 a and just anterior to the opening of the duct. Corresponds to Fig. 8 h of the preceding stage. (Mag. 90 diam.)

Fig. 1 g. Transverse section through the duct of the [illegible] stage. The lat-[illegible] in the pre-[illegible]

[illegible] posterior to the [illegible] stage. (Mag. [illegible])

[illegible] through the coiled [illegible] indicated in Fig. 1 [illegible]

[illegible] thyroid, [illegible] gland, to show the [illegible] extend for some [illegible]. The pseudobranch-[illegible] the large vessel. [illegible]

[illegible] of a loom. Petro-[illegible], [illegible] one side to [illegible] gland to the bars [illegible] Mag.)

[illegible] The [illegible] thyroid [illegible] less accu-[illegible] the [illegible] parts of the gland. The dotted lines indicate the planes through which the sections (Figs. 6 a-i) pass.

Fig. 9 a. [illegible] of the [illegible] semrotus.

[illegible] those [illegible] length. [illegible] rx and [illegible] latter [illegible]. (Mag. [illegible]

[illegible] Fig. 9 a, [illegible] cells.

[illegible] ventral half [illegible] position [illegible] gland.

[illegible] side of the [illegible] to the [illegible] Mag.)

Fig. 10 c. [illegible] ventral [illegible] with cell [illegible] gland.

Fig. 10 b. [illegible] would [illegible] about the plane of the section represented in Fig. 10 a. (Mag. 420 diam.)

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Note:- While arranging my notes for this investigation, I have collected together all the literature on the subject until I obtained, I think, a nearly complete bibliography of the Cyclostomes. This bibliography will probably appear shortly.

"Life."

The writer, Allen Moore Brune, was born at Lake Roland, Maryland, on the first day of April, 1872. His early education was obtained at the Todd's Preparatory and High School, in Baltimore, and he entered Johns Hopkins University in October, 1889, and took the Classical-Philological Course.

After receiving the A. B. degree in June, 1893, he taught for five years, during one of which years he was also working at the above University as a graduate student, with Geology as a major subject and Paleontology and Botany as first and second subordinates, respectively. He continued this line of work during the next three years and was appointed University Scholar for the years 1898-1899.

Baltimore, May 7, 1900.