ON THE SALIVARY AND MOUTH GLANDS OF THE NUDIBRANCHIATA.

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The Nudibranchs always have at least one pair of glands in connection with the anterior part of the alimentary canal—the salivary glands. They may, however, have another pair entering the mouth; these are of unknown function and are sometimes called ptyaline glands. It would be preferable, I think, to call them mouth glands until their function is known. It has been conjectured that the mouth glands may secrete a defensive juice, but as I have never observed a Nudibranch to turn its head towards a point of irritation—the papillæ are turned in that direction—this view cannot well be maintained. A more likely hypothesis is that the mouth glands secrete a fluid capable of dissolving the hard parts, calcareous or chitinous, of the Hydromedusæ on which the "slugs" feed.

Fig. I. represents the anterior portion of the alimentary canal and the attached two pairs of glands as seen in a dissection of *Spurilla neapolitana*; it is a dorsal view. The mouth gland of the left side E joins with its fellow of the opposite side—underneath the mouth—to form a common median duct which almost at once enters the mouth cavity A; the salivary gland D runs over the dorsal surface of the crop C, along the œsophagus and into the pharynx B; the ducts of the salivary glands run downwards and forwards in the muscles of the pharynx and enter the pharyngeal cavity separately, one on each side near the base of the tongue. The salivary glands, or their ducts, pass through the nerve collar.

Other animals studied by means of serial sections are: *Doto fragilis*, *Faceline Drummondii*, *Berghia*, *Calma Cavolinii*, *Coryphella*, *Rufibranchialis*, *C. lineata*, *Tritonia plebeia*, *Marionia*, *quadrilatera*, *Favorinus-albus*, and *Rizzolia peregrina*. Only *Spurilla*, *Doto*, *Facelina*, *Berghia*, and *Calma* have mouth glands.

The salivary glands have the histological structure typical for such glands; they only vary in size and position in the various genera. The

usual position for them seems to be in the body wall just underneath the first right and left bundles of dorsal papillæ. The salivary glands have this position in *Coryphella*, *Berghia*, *Favorinus*, and *Rizzolia*. In *Spurilla* they end in the body wall underneath the first bunch of papillæ, but the greater portion of the glands lie on the œsophagus and crop. In *Calma* the position is as for *Spurilla*. In *Tritonia* the salivary glands are short, stout structures lying along the œsophagus. In *Marionia* and in *Doto* the glands are voluminous and are spread around the posterior end of the pharynx. The ducts of the salivary glands pass, as already mentioned

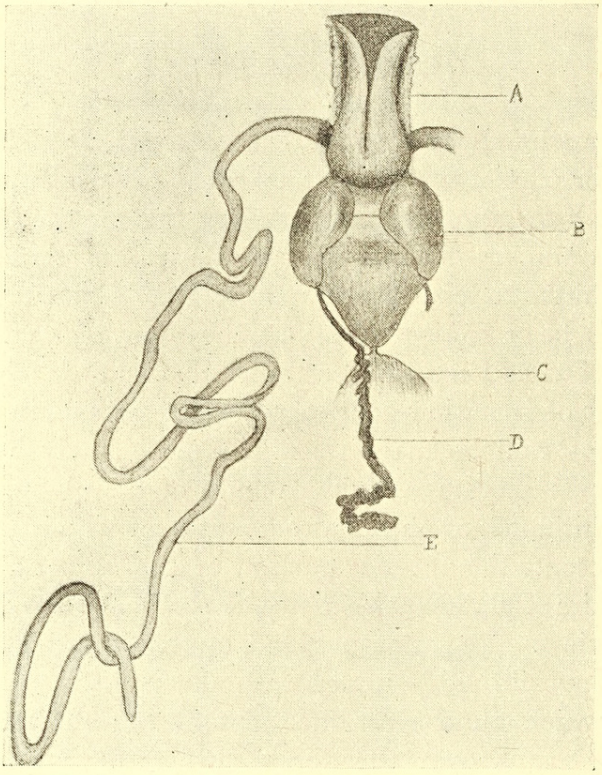

Fig. I.

along with œsophagus through the nerve chord; they are extremely delicate and may have a diameter of even less than ·005 mm.

The mouth glands agree in opening into the mouth cavity, but in nothing else. In *Calma*, *Spurilla*, *Berghia*, and *Facelina* there are right and left portions opening into a common duct which lies mid-ventrally to the pharynx. In *Doto*, however, there is only a left gland. In the others the glands are throughout their lengths muscular, or at least the common duct is muscular. In *Doto* the "reservoirs" of the gland are not muscular and neither is the median duct. In *Doto* the gland is acinose—in the others the glands are tubular.

Secretory cells of the mouth glands are very diverse in histological structure; they sit on the tubes or reservoirs either singly (*Spurilla* and *Doto*) or in groups of three or four (*Facelina*). They are always enveloped in a delicate connective tissue sheath the nuclei of which can be seen in Fig. II. and Fig. VI. 1. A comparison of Figs. IV. and VI. will show the absolutely different structure of the glands. The cells of *Facelina* can be described as follows: Nucleus large, poor in chromatin, rich in nuclear fluid, with large paranucleus; protoplasm with numerous deeply staining (iron-hæmatoxylin) spherical secretory globules which are seen to escape as minute drops into the lumen of the tube on which the cells sit; a

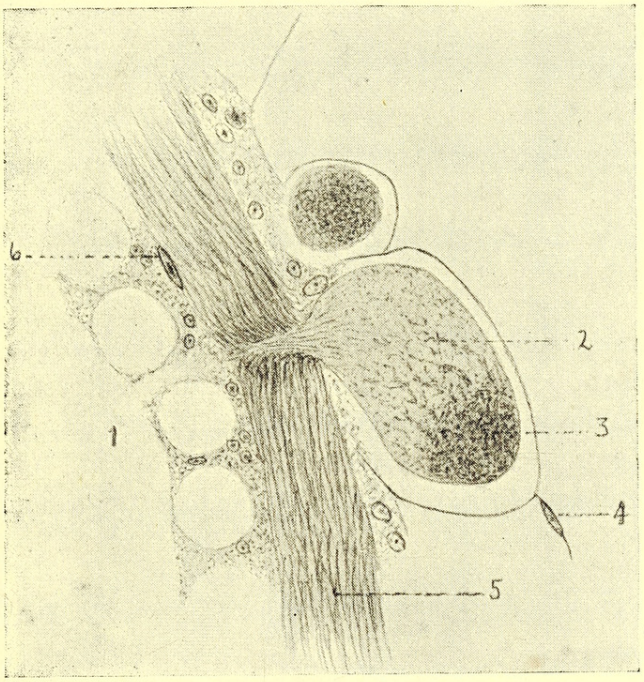

Fig. II.

portion of the protoplasm (Fig. IV.) near the base of the cells is free of globules. Fig. III. shows a group of cells (1 and 2) in active secretion, and another (3) apparently recuperating after a period of secretion.

The secretory cells of the mouth glands of *Doto* are remarkable in many ways. They are of enormous size, having diameters of up to ·4 mm. The nuclei are also enormous (Fig. VI. 2); they have a number of large karyosomes but no nucleoli. The protoplasm shows an unusual structure; there are two layers having a regular fibrillar structure—one layer immediately around the nuclear membrane and a peripheral layer; in cell 2 of Fig. VI. these two fibrillar layers are seen to be continuous at the point where the secretion is discharged from the cell. In cell 4 of the

same figure the perinuclear layer is seen in surface view, the section being one taken just before that in which the nucleus is cut into. The protoplasm also contains a reticulum of darker stained substance which is also aggregated in irregularly shaped masses. Other curious points are that there appear to be no separating membranes between the secretory cell

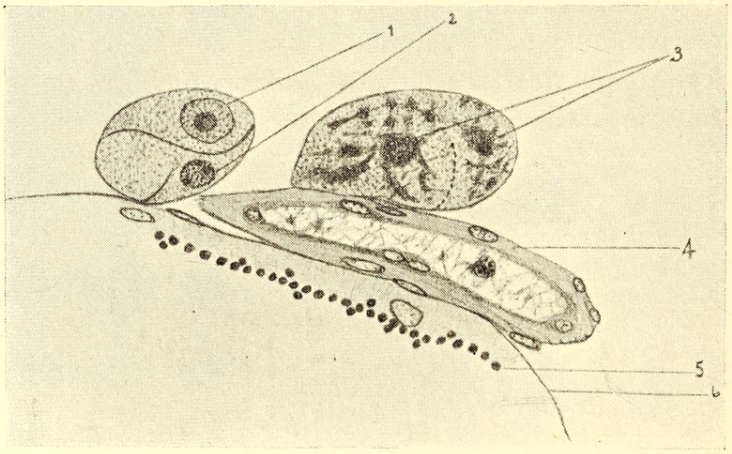

Fig. III.

and the adjoining cells of the "reservoir" and that the fibrillæ of the protoplasma of the secretory cell is continuous right through the cells of the reservoir. One would, of course, expect to see the secretory cells discharging by means of a neck situated in between the epithelial cells, but the glandular cell has apparently reached such an enormous size and such

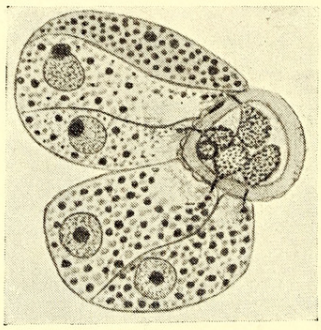

Fig. IV.

an active stage of secretion that it simply "drowns" the adjoining cells. This can be seen in a number of sections and the cells in the neighbourhood of the point of discharge of a secretory cell is always smaller and darker than those further off. The secretion is apparently discharged in a *continuous thin stream.* In the reservoirs it then takes the form of globules two of which are seen in the reservoir labelled 3 of Fig. VI.

In *Spurilla* the secretory cells resemble those of *Doto* rather than those of *Facelina*. Fig. II. shows such a cell with the nucleus at one end and the streamlets of secretory fluid running to the neck. The cells of *Calma* resemble those of *Facelina*. In the last-named animal we see three phases of secretion represented in Figs. III. and IV. Fig. IV. represents the cells in active function; cells 1 and 2 of Fig. III. shows the phase immediately prior to activity, and cell 3 of the same Fig. is probably the phase after a prolonged period of activity; there are two such cells, the nuclei of which are labelled 3; the nuclei are of irregular shape and indefinite outline and resemble the nucleus of the *Spurilla* cell (Fig. II.), but the two cannot represent equivalent phases since Fig. IV. represents the actively secreting cells of *Facelina*, and Fig. II. shows that also the *Spurilla* cell is in full activity.

The secretory cells of the mouth glands are thus of at least three types one, nucleus large and clearly defined, no nucleolus, perinuclear and peripheral fibrillæ of secretory fluid; two, nucleus large but rich in chromatin and irregularly defined, secretory fluid as streamlets between nucleus and neck of cell (*e.g.*, *Spurilla*); three, nucleus comparatively small, poor in chromatin; large nucleolus; secretion in form of globules scattered in form of large sphere around the nucleus and discharged through a minute neck.

If the secretory cells of the mouth glands show a diversity of structure, the tubes or reservoirs into which they discharge show an even greater diversity. I have already mentioned that the mouth glands are usually present as right and left halves opening into a common median duct running ventrally to the pharynx and opening into the mouth. The first point to be noticed is that the several Eolidids possess tubular mouth glands, whereas *Doto fragilis* has an acinose gland. The second point is that the tubes, or at least the common median ducts, are muscular, whereas in *Doto* there are no muscle fibres either in the walls of the separate alveoli nor in those of the median duct. The third point of difference is that in *Doto* the mouth gland is only represented by a left bunch of alveoli or reservoirs, the right having no chance of any great development since the available space on the right side is taken up by the genital organs. Besides the bunch of alveoli of the left side there is a glandular tube which opens into the median duct at the posterior end of the latter; it runs forwards with the median duct, lying on the dorsal surface of the latter and ending blindly just posterior to the opening of the median duct into the mouth. This outgrowth is composed of cells which are all glandular and has thus a structure not at all comparable to that of the mouth gland as exemplified by the left lobe, but it may nevertheless be the mouth gland of the right side which has not been developed owing to want of space.

The structure of the tubes must be described separately. Fig. V. shows two slightly oblique sections through the tubes of the mouth gland in the region underneath the first bunch of papillæ; a muscle fibre cell is seen running from the one to the other and the nuclei and plasma of other such cells are seen in cross-section surrounding the tubes. The tubes and muscle fibres are enveloped in an exceeding delicate sheath of connective tissue which is not seen in the drawing. The tubes themselves are shut in by a single layer of cells and have somewhat irregular lumina. The cells are of a peculiar structure and must be compared with the muscular epithelia of Hydra; the part of the cell towards the lumen is composed of clear protoplasm in which lies the nucleolated nucleus where-

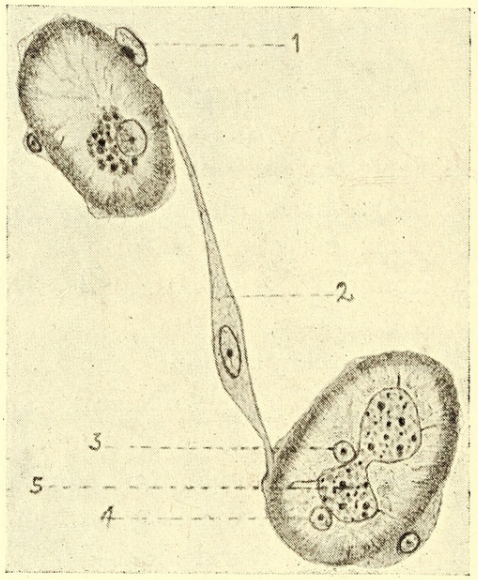

Fig. V.

as the peripheral part is striated. It may, of course, be that the striæ represent the secretion, but, as they are neither in the neighbourhood of the nucleus nor the lumen, this is not likely. It is probable that the striæ are muscle fibrillæ, stretched from centre to periphery, by means of which the tube may be compressed or dilated in order to force the secretion along the tube to the exterior.

The tubes of the mouth glands of *Spurilla* are extremely muscular (Fig. III.). The Fig. represents the best section which I could find and is not good although I even went to the pains of dissecting out and preserving for themselves these glands. On the outside are seen two secretory cells, then comes a layer of neutral cells, then a thick layer of muscle fibres very sparsely nucleated (one longish, dark nucleus can be seen on the inner side in the Fig.) and lastly, another layer of neutral cells in

which are large vacuoles which may have been filled with the secretion. The whole structure is enveloped in connective tissue which can be seen as a delicate membrane around the contracted secretory cells.

The tubes of *Calma* are very similar to those of *Facelina;* those of *Berghia* resemble to some extent those of *Spurilla.*

The structure of the alveoli of *Doto* is quite distinct. The whole organ is again enveloped in connective tissue, nuclei of which can be seen at the

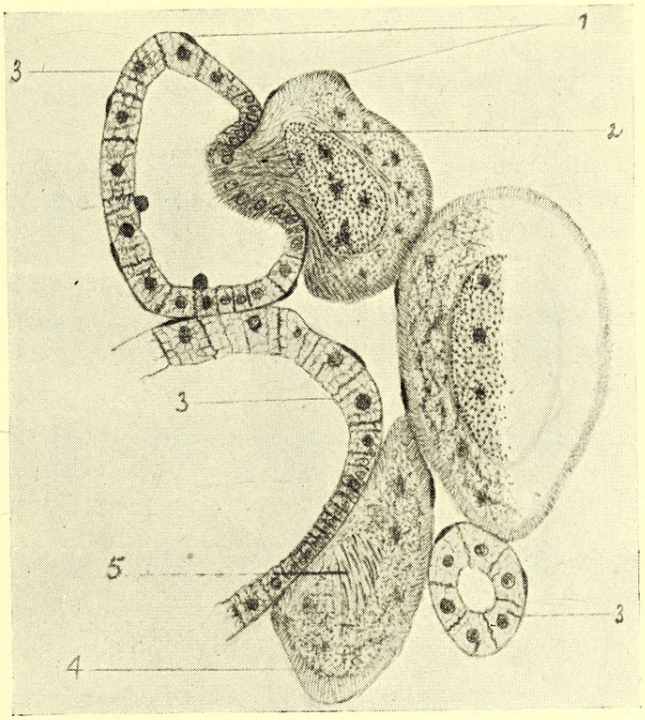

Fig. VI.

points marked 1 in Fig. VI. Each alveolus is composed of a single layer of epithelial cells, each of which has a fair-sized nucleus and a coarsely reticulated protoplasm ; the dividing cell walls are wavy in section which is due to the points of attachment of the reticulum drawing the walls now this way then the other. The cells in the neighbourhood of a secretory neck are small and stain darkly, whereas those further off are fairly large (ten or more times as large as former) and only the nuclei and reticulum are deeply stained.

EXPLANATION OF FIGURES.

FIG.

I. Dorsal view of the alimentary canal of *Spurilla neapolitana;* A = mouth; B = pharynx; C = crop; D = Salivary gland of left side; E = mouth gland of same side. From a dissection.

II. Cross-section of a piece of the mouth gland of *Spurilla.* 1 = lumen of tube; 2 = secretory cell with nucleus 3; 4 = nucleus of connective tissue envelope; 5 = muscle layer with a nucleus; 6 all the sections are stained with iron-hæmatoxylin.

III. Cross-section of mouth gland of *Facelina Drummondii.* 1 and 2 are cells before (?) secretory activity; 3 are nuclei of cells after (?) prolonged activity; 4 = tube with nuclei in wall; 5 and 6 parts of neighbouring receptaculum seminis.

IV. Cross-section of same as Fig. III. The cells are here shown in full function.

V. Same as III. and IV. but is taken where no secretory cells are attached. 1 and 2 muscle cells; 3 and 4 nuclei of wall cells of tube; 5 lumen of tube with secretion.

VI. Section of mouth gland of *Doto fragilis.* 1 = connective tissue nuclei; 2 = nucleus of excretory cell; 3 wall of alveoli; 4 = peripheral striated layer of secretory cell; 5 = perinuclear striated layer.