

EXPERIMENTAL OBSERVATIONS UPON THE ENDO- DERMAL GLANDS OF PELMATOHYDRA OLIGACTIS¹

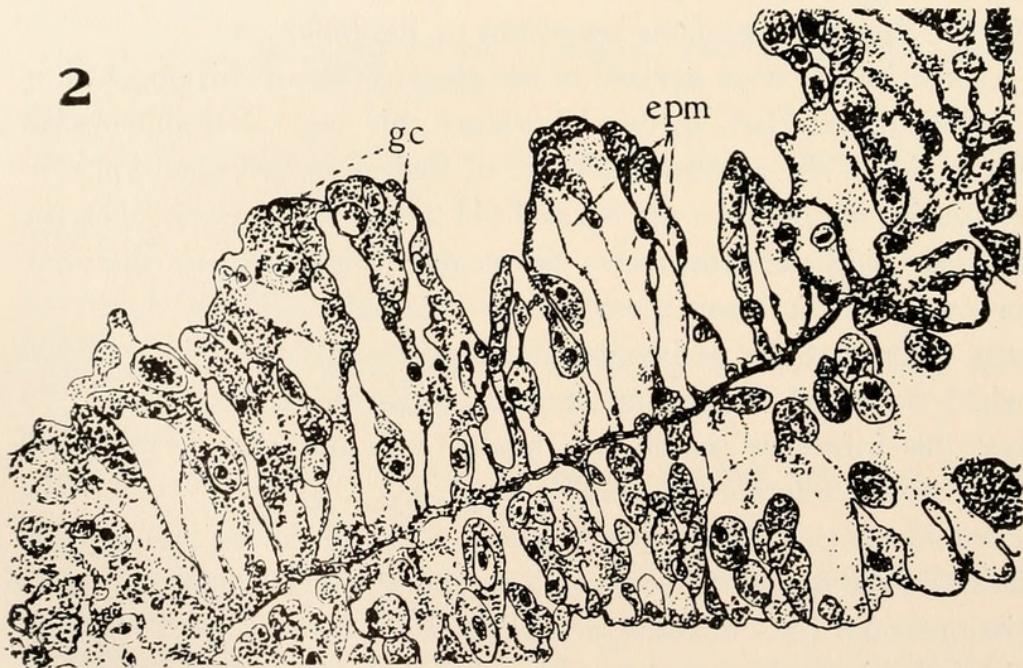
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The species dealt with was determined to be *Pelmatohydra oligactis* (Pallas) according to Schulze ('17). This polyp has been under frequent observation in this laboratory for years. Kepner and Hopkins ('24) described two sets of glands present in the endoderm of *Pelmatohydra oligactis*. These are, first, the peristomal glands located in the peristomal region around the mouth, and second, the isolated secretory cells scattered throughout the endoderm. The presence of these two sets of glands led to the suggestion that the secretions of one set might be essential for the functioning of the secretions of the other set.

Experiments were devised to test the validity of this suggestion. Threlkeld and Hall, in this laboratory this year, determined that the range of the greatest tolerance of hydras to hydrogen ion concentration lay between pH 8.0 and pH 7.6, in other words upon the alkaline side of neutrality. Since the first phase of digestive processes in the lower invertebrates is usually acid, the inference was made that the peristomal glands discharged an acid secretion which activated the general secretory cells of the endoderm. To test this inference search was made for a microscopic organism that would tolerate an alkaline medium. After several trials, *Paramœcium caudatum* was selected. This organism will live for hours in the range of hydrogen ion concentration which represents the optimum for *Pelmatohydra oligactis*. Having found this fact the following procedure was planned: Inject living paramœcia into two sets of polyps; one set having the peristomal glands and the other set having had them removed. To obtain the latter, normal hydras were placed under a binocular microscope and their

¹ These experiments were carried out at the suggestion of Dr. W. A. Kepner.



TEXT FIG. A.

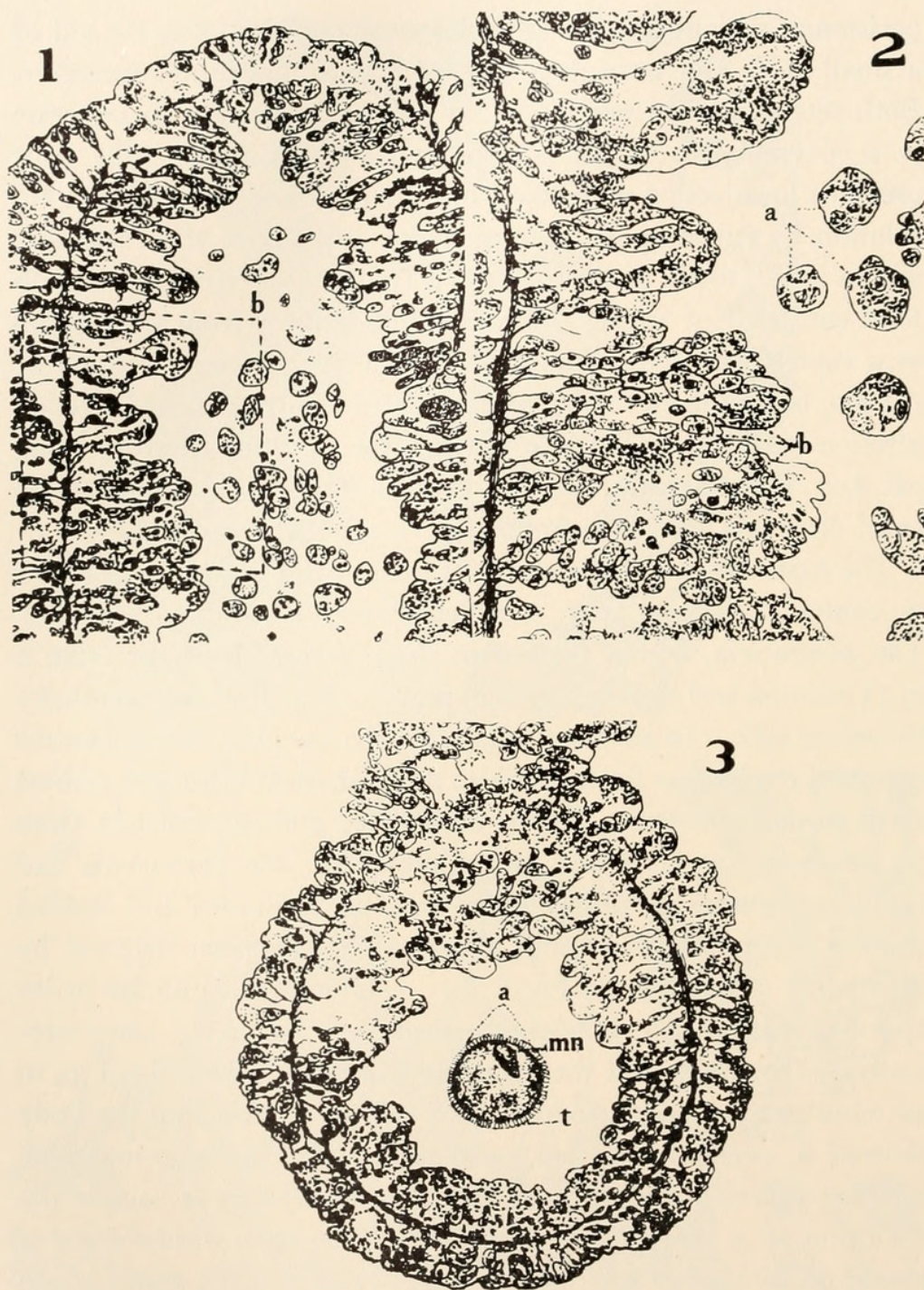
Explanation of Figures.

FIG. 1. Middle third of longitudinal section of complete polyp. *a*, wound made by pipette; *b*, remains of paramoecium 34 minutes after injection. $\times 750$.

FIG. 2. Region of endoderm of complete polyp showing condition 34 minutes after injection of paramoecia. Gland cells (*gc*) stand out clearly in contrast with vacuolated epithelio-muscular cells. (*epm*). $\times 1500$.

peristomal regions and the tentacles were removed with the aid of a small knife and were then allowed 8 to 10 hours to regenerate. Both sets of hydras were kept for 24 hours previous to injection in a covered dish in pH 7.8 solution without food. One hour previous to injection with food they were washed out with pH 8.0 solution by injecting it into the hydra just above the basal disc with a small, finely drawn pipette. The process of injection with food consisted of taking the paramœcia culture from the bottom of a centrifuge tube and mixing it with five times its volume of pH 8.2, being mixed in this proportion to insure that the injection solution would be well above neutral; the resulting mixture being pH 8.0. This mixture was also injected into the polyps above the basal discs and the hydras observed to see their reactions.

The first reaction of the complete hydra after such injection was to contract sharply, later contracting and expanding normally. The paramœcia, within the polyp, swam freely about for from 9 to 15 minutes and then began to appear in great distress, eventually becoming still. In all cases only after the paramœcia had become quiet did the hydras fix themselves by their basal discs and resume their normal positions. These were killed and sectioned in from 34 minutes to 1 hour and 40 minutes after the paramœcia had ceased swimming about. The sections when stained and studied showed paramœcia in various stages of having been digested by the hydras (Text Fig. *A*, Fig. 1, *b*). The endoderm of the hydra appeared normal and digestion appeared to be taking place normally. The sections of the complete hydras that were fixed 34 to 40 minutes after the introduction of the paramœcia into the body showed a perfectly normal endoderm. The epithelio-muscular cells are practically empty and highly vacuolated, as is usually the condition in a polyp from which food has been withheld for a period of 24 hours (text Fig. *A*, Fig. 2, *epm*). Not much of the material of the digested paramœcium had been absorbed during the relatively short period following the introduction of the ciliates into the coelenteron. Another feature that is characteristic of the normal hydras is that the gland cells of the general endoderm stand out in sharp contrast with the epithelio-muscular cells (Text Fig. *A*, *gc*) in that they have inclusions that are peculiar to themselves. No such inclusions are to be found in the epithelio-



TEXT FIG. B.

FIG. 1. Longitudinal section of oral third of incomplete polyp 24 hours after removal of peristome and tentacles. Note absence of peristomal glands. Specimen fixed 5 hours and 10 minutes after injection with paramœcia. *a*, some of numerous endodermal cells that had migrated into coelenteron; *b*, rectangle indicating region from which Fig. 2 has been taken. $\times 750$.

FIG. 2. Region of endoderm of incomplete polyp 5 hours and 10 minutes after being injected with paramœcia. *a*, endodermal cells that had migrated

muscular cells. (Text Fig. *A*, Fig. 2, *cpm.*) Another interesting feature of the histological picture presented by the complete polyps is the fact that in reacting to the introduced paramœcia few, if any, cells migrated from the epithelium of the endoderm into the cœlenteron (Text Fig. *A*).

The reactions of the hydras from which the peristomal glands had been removed were markedly different. Upon injection with paramœcia they expanded their fullest possible length and remained in this position for as much as twenty minutes. While in this position it was possible to see paramœcia swimming freely about in the cœlenteron. Eventually the hydras contracted to about one half their normal length. The paramœcia swam freely about and seemed to suffer no inconvenience from their close confinement. These hydras were observed for from 1 hour to 5 hours and eventually each of them egested the living paramœcia which swam freely away. Parenthetically, it may be of interest to record that not until the hydras had freed the paramœcia did they attach their basal discs to the substrata. This was done, however, by all of them after the paramœcia had been egested. It was interesting to observe that after having remained within these hydras for such long periods the paramœcia swam away in perfect condition. Not even their cilia appeared to have been eroded by digestive enzymes. But another observation was made that later proved to bring out, in sharp contrast, the reaction of the two sets of polyps upon which the experiment was performed. This observation was made upon many masses of refractive material which were thrown out of the cœlenteron together with the egested paramœcia from the incomplete hydras that had been injected with paramœcia. Upon examination under the 4 mm. objective, these masses appeared like minute conglomerations within which were many refractive bodies. In some cases an opaque, more or less centrally disposed body was seen. There

into cœlenteron; *b*, indicates the many inclusions to be found within the endoderm, which make it difficult to distinguish gland cells and epitheliomuscular cells. $\times 1500$.

FIG. 3. Oblique transverse section through the basal third of polyp shown in Fig. 1. Observe transverse section of paramœcium (*a*) that shows no erosive effects of digestive enzymes. At the time the polyp was fixed paramœcium was alive, though 5 hours and 10 minutes had passed since it and many of its fellows had been injected into the polyp. *mn*, meganucleus; *t*, trichocysts. $\times 750$.

were numerous such masses ejected in the case of each incomplete hydra. Their unstained condition suggested that they might have been general endodermal secretory cells that had left the epithelium of the endoderm.

These observations make the histological pictures of the incomplete hydras of interest. The histology of these hydras show that, in the first place, the introduced paramœcia had not been attacked by digestive enzymes. In one case, a paramœcium that had remained 5 hours and 10 minutes within the polyp and did not happen to be egested with its fellows was found in the sections. It proved to be well fixed, stained and sectioned. Even the trichocysts were clearly seen to be undischarged and lying within the ectoplasm (Text Fig. B, Fig. 3, a). Another conspicuous feature of the histology of these incomplete hydras is that there are numerous spheroidal inclusions within all the endodermal cells. These inclusions so much resemble those ordinarily encountered in the general gland cells of the endoderm and not ordinarily found in the epithelio-muscular cells, that one cannot here distinguish between general gland cells and epithelio-muscular cells with certainty (Text Fig. B, Fig. 2, b). Moreover, the histology of these polyps indicates that, though many cell-like bodies had been egested with the paramœcia, there yet remained numerous freed bodies which in the sectioned and stained material proved to be actually cells that had migrated from the epithelium of the endoderm (Text Fig. B, Fig. 1, a and Fig. 2, a).

SUMMARY.

It appears that the presence of peristomal cells are necessary for the killing and digestion of paramœcia when they are thrown into the coelenteron that has been previously rinsed out with an alkaline medium. This raises the suggestion that the preliminary (acid) phase of digestion is induced by the secretions of the peristomal gland cells.

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