

THE ALIMENTARY CANAL OF THE APHID *PROCIPHILUS TESSELATA* FITCH.

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INTRODUCTION

The Woolly Alder Aphis (*Prociphilus tessellata* Fitch), is a sucking insect feeding on alder. It is commonly found throughout the State of Ohio.

The study that follows was made upon the suggestion of Dr. C. H. Kennedy, and was begun in a course on "The Morphology and Development of Insects."

The material used was collected on the bank of Minerva Lake, at Columbus, Ohio, October 9, 1936. The aphids were brought into the laboratory and kept alive on a branch of alder for several weeks. Live material was kept alive in the laboratory and used from time to time over a period of five weeks. Specimens were opened and fixed in Kahle's solution for 24 hours, and preserved in 70% alcohol.

The author wishes to express his appreciation for the helpful suggestions and criticisms of Dr. C. H. Kennedy, under whose direction this study was made.

GROSS ANATOMY OF THE DIGESTIVE TRACT

General Anatomy

The alimentary canal consists of a long tube with a few convolutions, which is characteristic of sucking insects. The canal is approximately two and one-half times the length of the insect's body. Morphologically the canal is divisible into three primary regions according to their embryonic origin. The fore-intestine (stomodaeum) arises as an anterior ectodermal invagination, the hind-intestine (proctodaeum) arises as a similar posterior invagination; while the epithelium on the mid-intestine arises from embryonic endoderm, the muscular layers in the same region are derived from mesodermal tissue.

Fore-Intestine

The fore-intestine is a comparatively short, slender tube which consists of the following regions: pharynx, oesophagus, and oesophageal valve.

The pharynx is the slight enlargement of the fore-intestine just posterior to the mouth which connects the mouth with the oesophagus.

The oesophagus is a short, narrow tube connecting the pharynx with the mid-intestine (Pl. I, fig. 1). It is located running through the prothorax and mesothorax. At the junction of the oesophagus

and the mid-intestine is located the oesophageal valve which projects into the lumen of the mid-intestine.

The oesophageal valve is rather well developed and marks the division between the fore-intestine and mid-intestine. It is found near the junction of the mesothoracic and metathoracic segments.

The salivary glands are represented by two small oval bodies located dorsally, left and right respectively to the oesophagus between the prothoracic and mesothoracic segments (Pl. I, fig. 1). They connect with the oesophagus by a simple forked tube.

Mid-Intestine

The mid-intestine, mesenteron, forms about two-thirds of the alimentary tract (Pl. I, fig. 1). It is marked at its anterior end by the oesophageal valve, located near the anterior part of the metathoracic segment, and at the posterior end by the pyloric valve located in the first abdominal segment. The size of the mid-intestine or stomach varied with the different specimens dissected. The anterior part of the mid-intestine is shaped like a large bulb with a small constriction at the posterior part of the bulb. The stomach runs posteriorly to the ninth abdominal segment where a turn occurs, a short lateral wave with a complete reverse turn cephalad to the middle of the metathoracic segment where it folds a figure U dorsally on the bulb part of the stomach. After forming the U, the stomach bends down around the bulb part and turns back posteriorly on the ventral side of the bulb, where the pyloric valve occurs in the anterior part of the first abdominal segment, or as far forward as the metathorax. No malpighian tubules were found. Weber, in his "Lehrbuch der Entomologie," states that aphids lack malpighian tubules.

Hind-Intestine

The hind-intestine lacks malpighian tubules, and consists of a pyloric valve and a sac-like portion, having the structure of a rectum, which gradually enlarges toward the anus. G. F. Knowlton found the hind-intestine of *Longistigma caryae* (Harris) connects with the anus by a thick-walled rectum which has only a small opening through the center.

The pyloric valve is recognized by the constriction at the posterior end of the mid-intestine (Pl. I, fig. 5). It is located in the posterior part of the metathoracic segment, or in the first abdominal segment.

HISTOLOGY OF THE ALIMENTARY CANAL

Fore-Intestine

The fore-intestine is histologically composed of the same parts throughout its length, but there is some variation in development of the parts.

The intima, or cuticula of chitin, is homologous with the cuticula of the body-wall. It is thin and very delicate for most of the distance through the fore-intestine, which it lines throughout.

The epithelium is thin, the cells are small rectangular, the nuclei of medium size, oval to round and quite centrally located. Nucleus

and cytoplasm are granular. The basement membrane cannot be distinguished.

Outside of the epithelial layer are found delicate scattered strands of longitudinal muscles at irregular intervals.

Surrounding the longitudinal muscles is a fairly continuous layer of circular muscles.

The oesophageal valve (Pl. I, fig. 4), marks the junction of the fore-intestine with the mid-intestine. The valve consists of a fold of epithelium, delicate cuticula from the oesophagus, which extends well into the fore-end of the mid-intestine. The folds of epithelium then turn back and join the large stomach digestive epithelium cells at the point where the oesophagus enters the mid-intestine. Histologically the parts coincide with the same structures in the oesophagus.

Mid-Intestine

The mid-intestine or stomach is the part of the alimentary canal posterior to the oesophageal valve and anterior to the pyloric valve.

The mid-intestine is quite long, being about two-thirds the length of the entire tract and easily distinguished from the other parts of the tract.

No evidence of the peritrophic membrane could be found. G. F. Knowlton, working on *Longistigma caryae*, found: "The peritrophic membranes or some membranous tissue is found covering the inner surface of the digestive epithelium cells in the closed and partly closed portion of the stomach, but is not present apparently, in the open stomach except where no signs of recent digestion are in evidence."

The ring of columnar shaped cells in the stomach around the oesophageal valve (Pl. I, fig. 4) may be the remains of the cells that secrete the peritrophic membrane in such insects as have a peritrophic membrane. E. P. Breakey, working on *Anasa tristis*, found a similar ring of cells and suggested that they may represent a ring of "peritrophic cells." So it appears for the first time that a circle of "peritrophic cells" has been found in Aphids.

The digestive epithelium is composed of large irregular cells with large oval nuclei, and the cytoplasm as well as the nucleus granular.

The basement membrane is a rather thick, structureless membrane and quite distinct.

The muscular layer is composed of circular fibers next the basement membrane, outside of which are thin strands of longitudinal fibers. The order of these layers is just the reverse of that of the muscular layers on the oesophagus, where the longitudinal fibers are inside the layer of circular fibers. The two layers are reversed at the oesophageal valve where the bundles of fibers interlace.

Hind-Intestine

The hind-intestine, more than half as long as the aphid, is marked anteriorly by the pyloric valve and posteriorly by the anus.

The pyloric valve, (Pl. II, fig. 9), consists of a slight constriction and differentiation of cells. The large irregular cells of the mid-intestine end abruptly and the irregular columnar cells of the hind-intestine arise. For the first time, so it appears, a pyloric valve has been found and

identified in the Aphids. This pyloric valve lacks a muscular band and cannot close. As a result, the pyloric valve is not a true valve as such.

The intima is delicate but clearly distinguishable.

The epithelium consists of irregular columnar shaped cells with oval shaped nuclei and with the cell walls seldom distinguishable.

The hind-intestine gradually enlarges into a rectum (Pl. II, fig. 10), the cells increasing slightly in size.

The basement membrane of the epithelium is structureless and rather indistinct.

The inner circular muscles form a delicate layer throughout the length of the hind-intestine. The longitudinal muscles are delicate, scattered strands. No outer circular muscles are in evidence.

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EXPLANATION OF PLATES

PLATE I

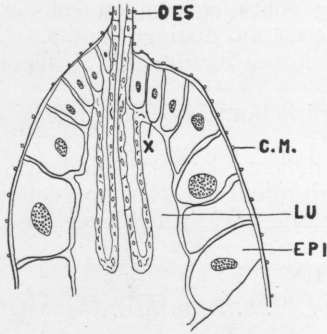
- Fig. 1. Gross dissection; dorsal view of alimentary canal and salivary glands to show relative size and relation of parts.
- Fig. 2. Cross-section through a salivary gland.
- Fig. 3. Cross-section through the oesophagus.
- Fig. 4. Longitudinal section through a portion of the oesophagus, the oesophageal valve and part of the stomach.
- Fig. 5. Gross dissection; ventral view of portion of alimentary canal showing relative size and location of pyloric valve.
- Fig. 6. Cross-section through constriction at posterior end of bulb part of mid-intestine.

PLATE II

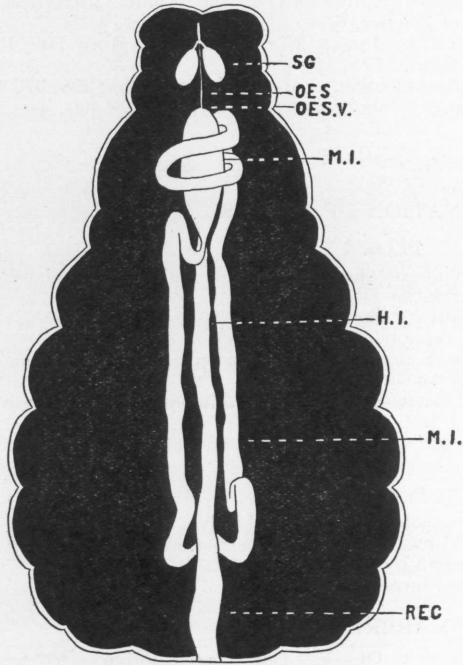
- Fig. 7. Cross-section through stomach at oesophageal valve.
- Fig. 8. Cross-section through mid-intestine below constriction.
- Fig. 9. Longitudinal section through pyloric valve.
- Fig. 10. Cross-section through hind-intestine, rectum.

KEY TO ABBREVIATIONS

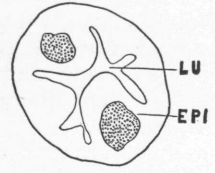
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|------------------------|---------------------------------|
| C. M.—Circular Muscle. | Oes. V.—Oesophageal Valve. |
| EPI.—Epithelium. | P. O.—Projection of oesophagus. |
| H. I.—Hind-intestine. | P. VLV.—Pyloric Valve. |
| INT.—Intima. | R. C.—Regenerative cell. |
| LU.—Lumen. | REC.—Rectum. |
| MI.—Mid-intestine. | S. G.—Salivary Gland. |
| Oes.—Oesophagus. | X—Columnar "peritrophic cell." |



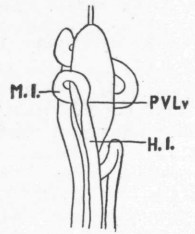
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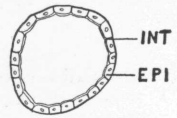
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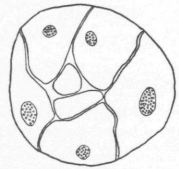
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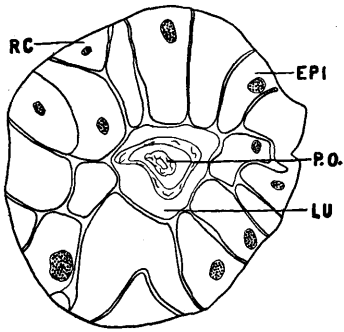
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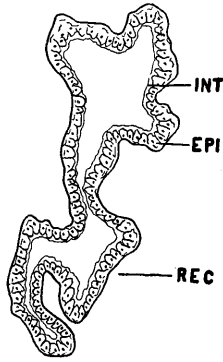
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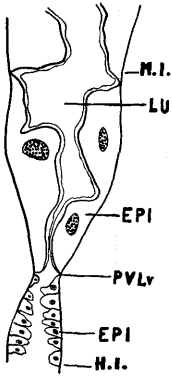
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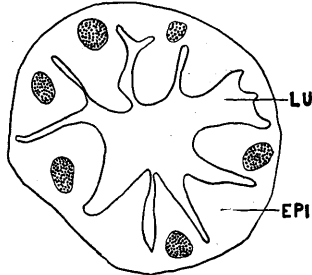
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