THE ALIMENTARY CANAL OF THE ORIENTAL FRUIT MOTH LARVA

RALPH B. NEISWANDER
Ohio Agricultural Experiment Station
Wooster, Ohio

The oriental fruit moth, *Grapholitha molesta* Busck, was first found in Ohio in 1925 but spread rapidly throughout the State and has now become the major peach pest. Although the literature dealing with this insect has become voluminous, so far as the writer is aware, practically nothing has been published on the internal morphology of the insect. It seemed desirable, therefore, that such a study be undertaken.

The writer has been engaged in a study of the biology and control of the oriental fruit moth at the Ohio Agricultural Experiment Station for a number of years and, consequently, had an abundance of live material available. Fresh material, consisting of full-grown hibernating larvae, was used in all dissections. The larvae were killed in hot water and dissected either in saline solution or in tap water. The stains used in the preparation of slides were limited chiefly to Haemalum and Fast Green FCF—Haemalum for nuclei and Fast Green for cytoplasm and cell walls.

The larva of the fruit moth, as well as the other stages of the insect, has been described by Garman (1), Peterson and Haeussler (4), and Stear (5); consequently, no further description will be included here.

The position of the different parts of the digestive tract in relation to the body segments varies with the degree of extension of the body. The description given here is that of the digestive tract of a larva in which the body segments are partly extended.

Gross Anatomy of the Digestive Tract

The alimentary canal of the oriental fruit moth is a straight tube extending from the mouth to the anus (Fig. 1). The fat-body forms a sheath almost completely surrounding the tract and apparently supports

Note: This study was begun at Ohio State University in a course on "The Morphology and Development of Insects," given by Dr. C. H. Kennedy. The writer desires to express his appreciation to Dr. Kennedy for his suggestions and criticisms.

it to some extent. The canal is constricted locally, and the three main divisions—the fore-intestine, mid-intestine, and hind-intestine—are rather easily distinguished. The various parts of these divisions are not very evident from a superficial examination.

FORE-INTESTINE, SALIVARY GLANDS, AND SILK GLANDS

The pharynx, which is very small, is located within the head. Arising from the pharynx are bundles of muscles attached to the head capsule.

Two salivary glands open separately into the mouth beside the pharynx. These glands consist of two long, coiled tubes, one on each side of the alimentary canal, which lie in folds chiefly in the region of the thorax. The anterior end, which lies very close to the pharynx, becomes exceedingly small and is closely enclosed in muscles.

The silk glands also consist of two tubes, one lying on each side of the digestive tract. The two tubes are similar and extend, with many convolutions, in a caudal direction as far as the fourth abdominal segment. They lie in folds in the adipose tissue and, when fully extended, are approximately as long as the body of the larva. The two tubes become smaller anteriorly and join together in the head on the ventral side of the pharynx. They become very small at this point and were not traced further.

A slight constriction in the alimentary canal back of the head indicates the beginning of the oesophagus. There is no apparent distinction between the oesophagus and crop. At approximately the middle of the metathorax a distinct, abrupt enlargement indicates the beginning of the mid-intestine.

MID-INTESTINE

The mid-intestine, which constitutes more than half of the entire length of the alimentary canal, continues without much change except a slight decrease in diameter from the metathorax to the sixth abdominal segment. A distinct enlargement in this segment indicates the pyloric valve and the beginning of the hind-intestine.

HIND-INTESTINE

The attachment of the malpighian tubes just posterior to the pyloric valve also marks the beginning of the small intestine. These tubes arise in two small pouches or bladders (Figs. 1 and 7), one on each side of the anterior end of the ileum. These pouches apparently are structures about which little is known. Similar pouches have been figured, however, by Peterson (3) for the tomato worm, *Protoparce sexta* Johan. One tube arises from each pouch and extends anteriorly a short distance to approximately the anterior end of the sixth abdominal segment, where each tube divides. The four tubes then continue in a cephalic direction along the walls of the mid-intestine to the anterior portion of the fourth abdominal segment. At this point one tube on each side divides again, forming six tubes. These turn abruptly and, with many convolutions, follow caudad along the walls of the alimentary canal to the rectum. All of the six tubes enter the walls of the rectum.

The ileum is a narrow, straight tube extending to the posterior portion of the eighth abdominal segment. A slight stricture followed by a bulb-like enlargement indicates the colon, which is short. The rectum appears as a distinct enlargement just posterior to the colon.

Histology of the Alimentary Canal

FORE-INTESTINE

A histological examination of the fore-intestine revealed no unusual structures. The chitinous inner lining, or intima, is prominent and in the proventriculus, chitinous teeth are very evident (Fig. 3). Cell walls in the epithelium were not distinct in the slides prepared, but nuclei were prominent. Longitudinal muscles appear in isolated strands inside a continuous layer of circular muscles. The circular muscles are large, as shown in Figures 2 and 3.

The oesophageal valve is well developed and marks the division between the fore- and mid-intestine.

MID-INTESTINE

In the mid-intestine the cells of the digestive epithelium apparently vary in size and shape, depending upon their physiological condition at the time the insect was killed. In most of the specimens studied the cells were long and narrow as shown in Figure 4, and the inner edge indicated holocrine secretion. In a few specimens the cells were short and gave little evidence of a broken or striated border. The nuclei are prominent and usually lie near the base of each cell. The muscles are much smaller than in the fore-intestine, and the longitudinal muscles lie in strands outside the continuous layer of circular muscles. The longitudinal muscle strands are much more numerous than in the fore-intestine and occur at regular intervals around the stomach.

HIND-INTESTINE

The hind-intestine, as mentioned previously, is marked anteriorly by the pyloric valve and the attachment of the malpighian tubes. The pyloric valve (Fig. 6) consists of long, fan-shaped epithelial cells.

The cells of the malpighian tubes are large and spongy, with the inner border distinctly striated (Fig. 11). An enlarged section of one of the pouches in which the tubes arise is shown in Figure 7. The walls contain a distinct muscular layer and the epithelium of the ileum apparently extends into the pouch.

The ileum in cross section appears similar to the oesophagus. The circular muscles are large and the inner lining is prominent.

The colon, as shown in Figure 8, is apparently a bulb-like enlargement of the hind-intestine and is marked by large circular muscles.

A cross section of the rectum (Figs. 9 and 10) shows a continuous row of malpighian tubes inside the walls. The tubes lie between the epithelial tissue and a double, thin membrane which has been described by Ishimori (2). However, Ishimori described two rows of malpighian vessels inside the walls of the rectum in Lepidopterous larvae, but the writer has been able to distinguish but one in the fruit moth.

The chitinous inner lining of the rectum is prominent, and the longitudinal muscles appear in large isolated strands outside of the layer of continuous circular muscles.

LITERATURE CITED

(1) **Garman, Philip.** 1930. The oriental peach moth in Connecticut. Conn. Agr. Exp. Sta. Bull. 313.
(2) **Ishimori, Naoto.** 1924. Distribution of the malpighian vessels in the wall of the rectum of lepidopterous larvae. Ann. Ent. Soc. Amer., Vol. 17, No. 1, pp. 75–86.
(3) **Peterson, Alvah.** 1921. Anatomy of the tomato worm larva, *Protoparce carolina*. Ann. Ent. Soc. Amer., Vol. 5, No. 3, pp. 246–272.
———and **G. J. Haeussler.** 1930. Life history of the oriental peach moth at
(4) Riverton, N. J., in relation to temperature. U. S. Dept. Agr. Tech. Bull. No. 183.
(5) **Stear, J. R.** 1929. The oriental fruit moth in Pennsylvania. Pa. Dept. Agr., Vol. 12, No. 8.

EXPLANATION OF PLATES

PLATE I

FIG. 1. Diagrammatic dorsal view. Salivary gland and malpighian tube pulled out of position to show approximate length.
FIG. 2. Cross-section through the oesophagus.
FIG. 3. Cross-section through the lower end of the oesophagus or proventriculus showing the chitinous teeth.
FIG. 4. Cross-section through the mid-gut.

PLATE II

FIG. 5. Cross-section through the ileum, or small intestine.
FIG. 6. Longitudinal section through the pyloric valve showing a pouch from which the malpighian tubes arise.
FIG. 7. An enlarged longitudinal section through a pouch or bladder.
FIG. 8. Longitudinal section through the colon and rectum.
FIG. 9. Cross-section through the rectum.
FIG. 10. An enlarged portion of a cross-section through the rectum, showing the row of malpighian tubes.
FIG. 11. Cross-section through a malpighian tube.

SYMBOLS USED IN PLATES

BL.....Bladder of malpighian tube.
C. M....Circular muscle.
COL.....Colon.
C. TIS...Connective tissue.
EPI.....Epithelium.
H. I.....Hind-intestine.
IL.....Ileum.
INT.....Intima, or inner chitinous lining.
L. M....Longitudinal muscle.
M. I.....Mid-intestine.
M. T....Malpighian tube.
OES.....Oesophagus.
PH.....Pharynx.
P. V.....Pyloric valve.
REC. ..Rectum.
S. B.....Striated border.

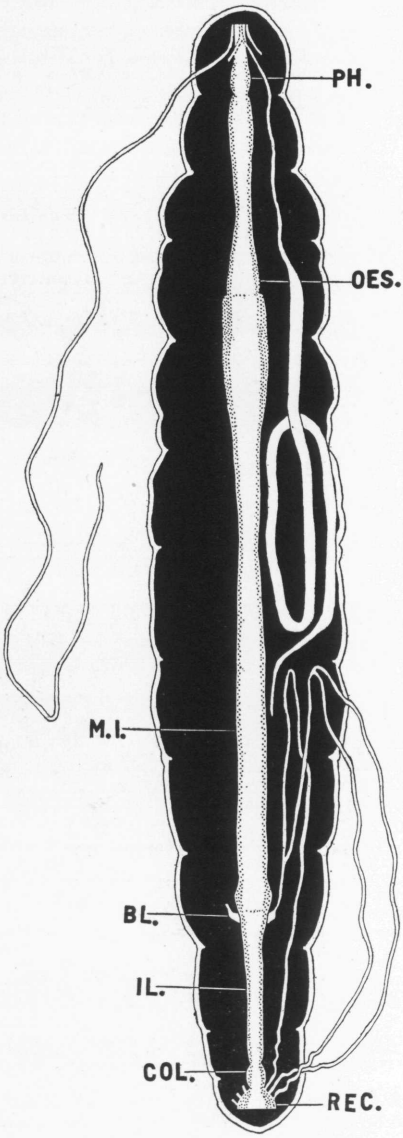

FIG. 1

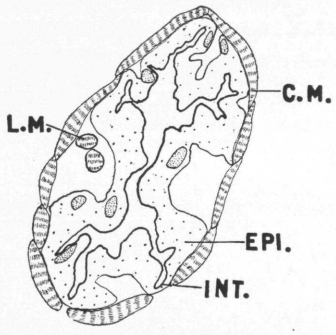

FIG. 2

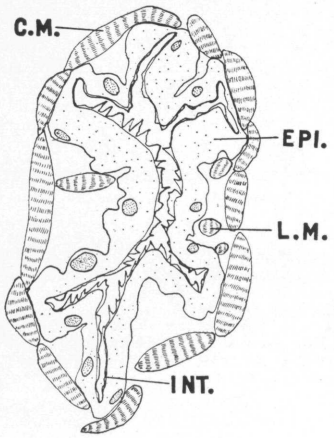

FIG. 3

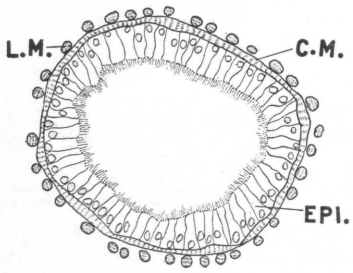

FIG. 4

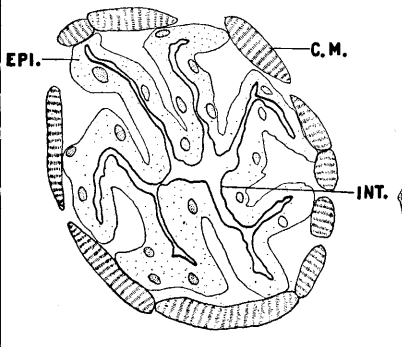

FIG. 5

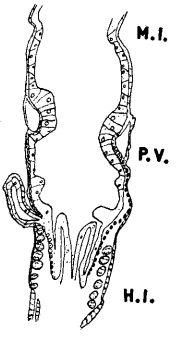

FIG. 6

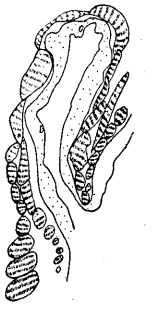

FIG. 7

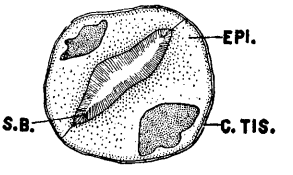

FIG. 11

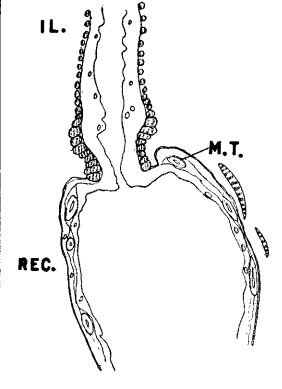

FIG. 8

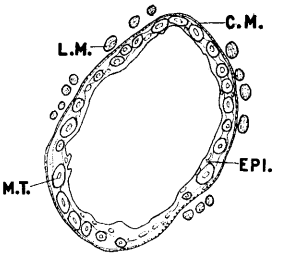

FIG. 9

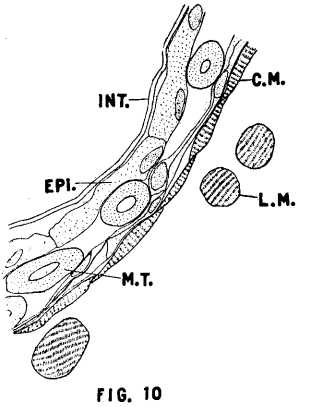

FIG. 10