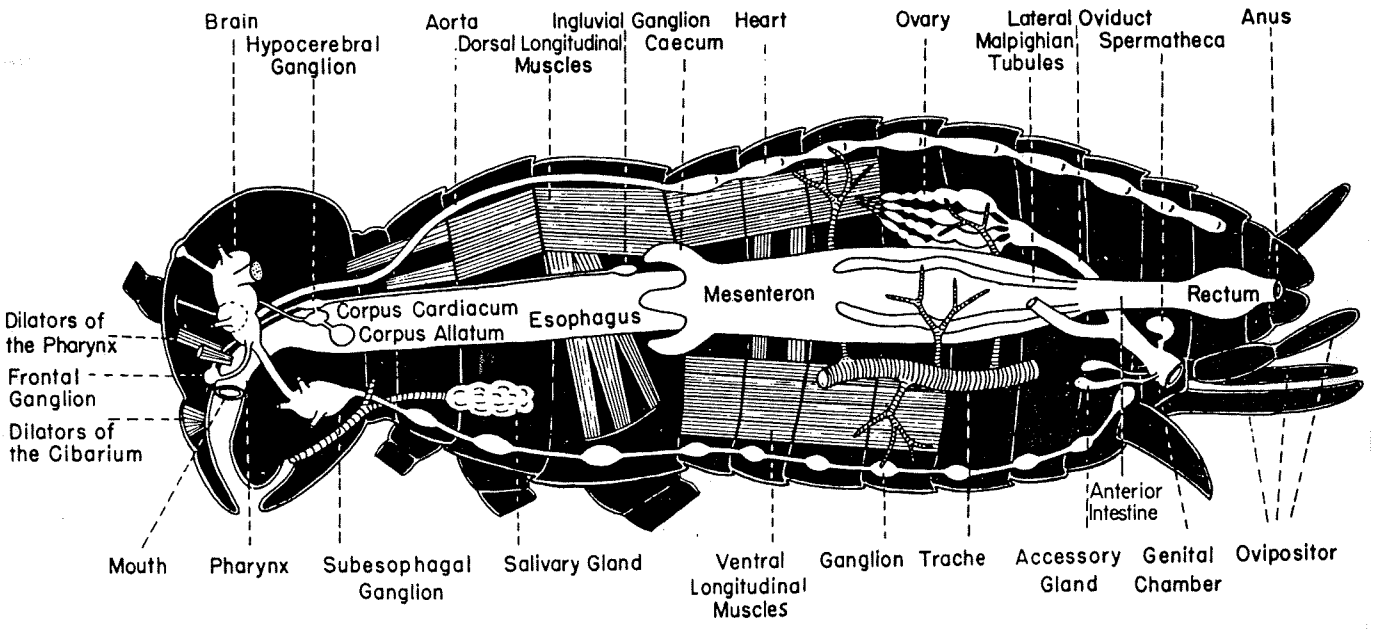


FIGURE 10. The positions and relationships of the principal internal organs.

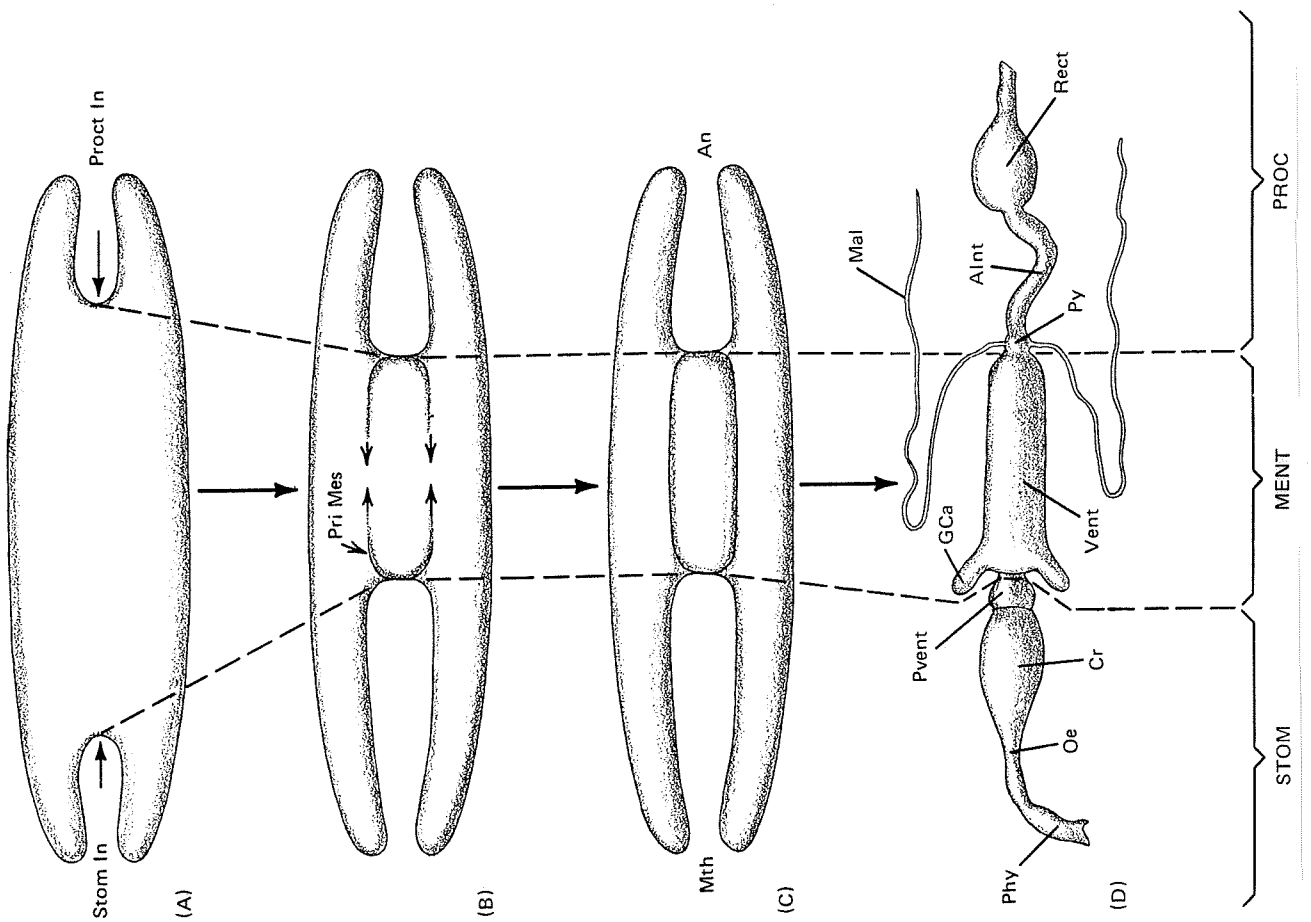


**Figure 57** Embryonic development and specialization of the alimentary canal. (A) stomodeal inpouc[illegible]occurs at anterior and proctodeal inpouching at the posterior; (B) primordial mesente[illegible] forms at ends of inpouchings; (C) mesenteral elements unite to form blind sac; (D) regions between stomodeum, mesenteron, and proctodeum split to form continuous tube or alimentary canal. Specialization occurs to produce specific structures: AInt, anterior intestine; An, anus; Cr, crop; GCa, gastric caecum; Mal, malpighian tubule; Ment, mesenteron; Mth, mouth; Oe, esophagus; Phy, pharynx; Proc, proctodeum; Pvent, proventriculus; Py, pylorus; Rect, rectum; Stom, stomodeum; Vent, ventriculus. [Part (D) redrawn with slight modifications from Snodgrass, 1935]

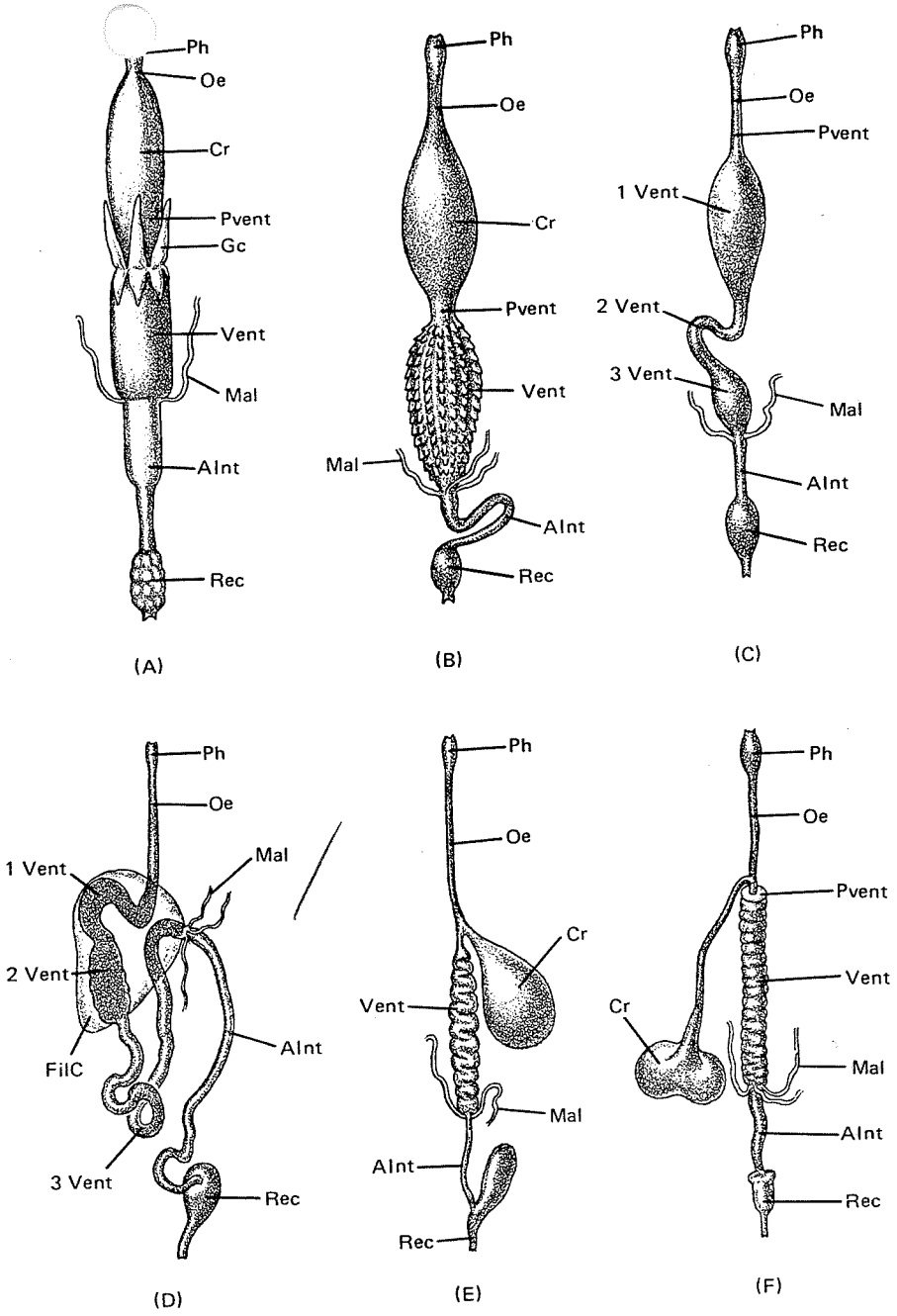


**Figure 58.** Some variations in the alimentary canal in insects. (A) grasshopper; (B) ground beetle; (C) water strider; (D) cicada; (E) moth; (F) housefly; AInt, anterior intestine; FilC, filter chamber; Gc, gastric caecum; Mal, malpighian tubules; Oe, esophagus; Ph, pharynx; Pvent, proventriculus; Rec, rectum; Vent, ventriculus.

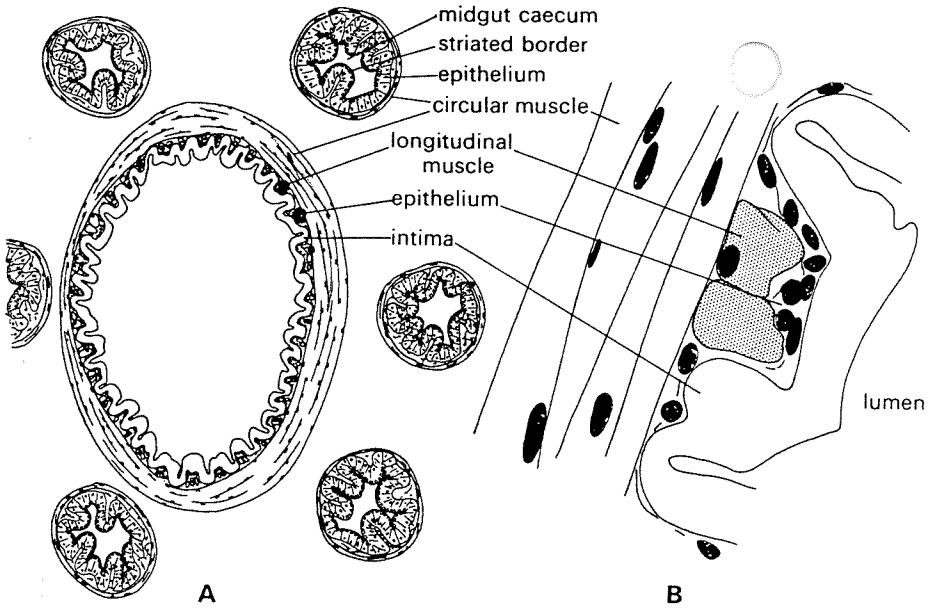


Fig. 28. A. Transverse section of foregut and midgut caeca of *Chorthippus*. B. Section of the foregut more highly magnified.

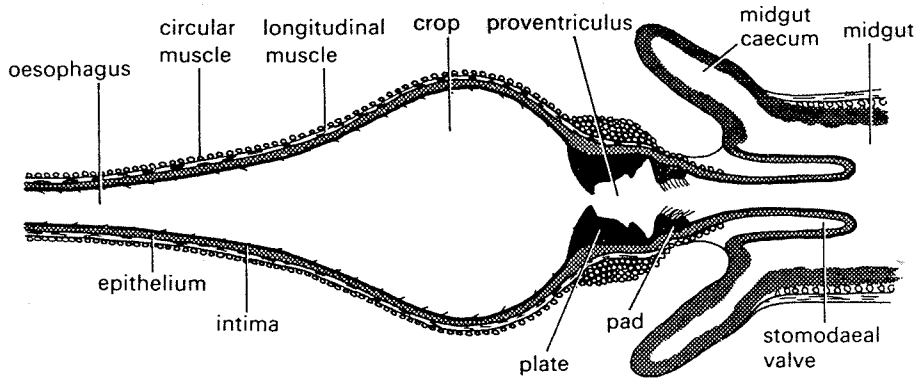


Fig. 30. Longitudinal section of the foregut of *Periplaneta* (after Snodgrass, 1935).

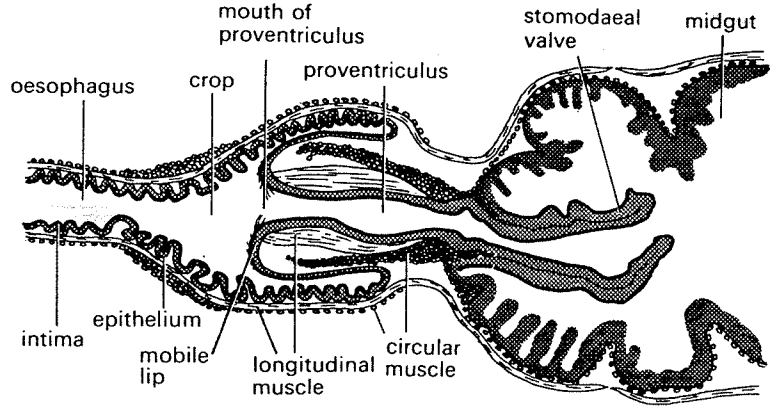


Fig. 31. Longitudinal section of the proventriculus of *Apis* (after Snodgrass, 1956).

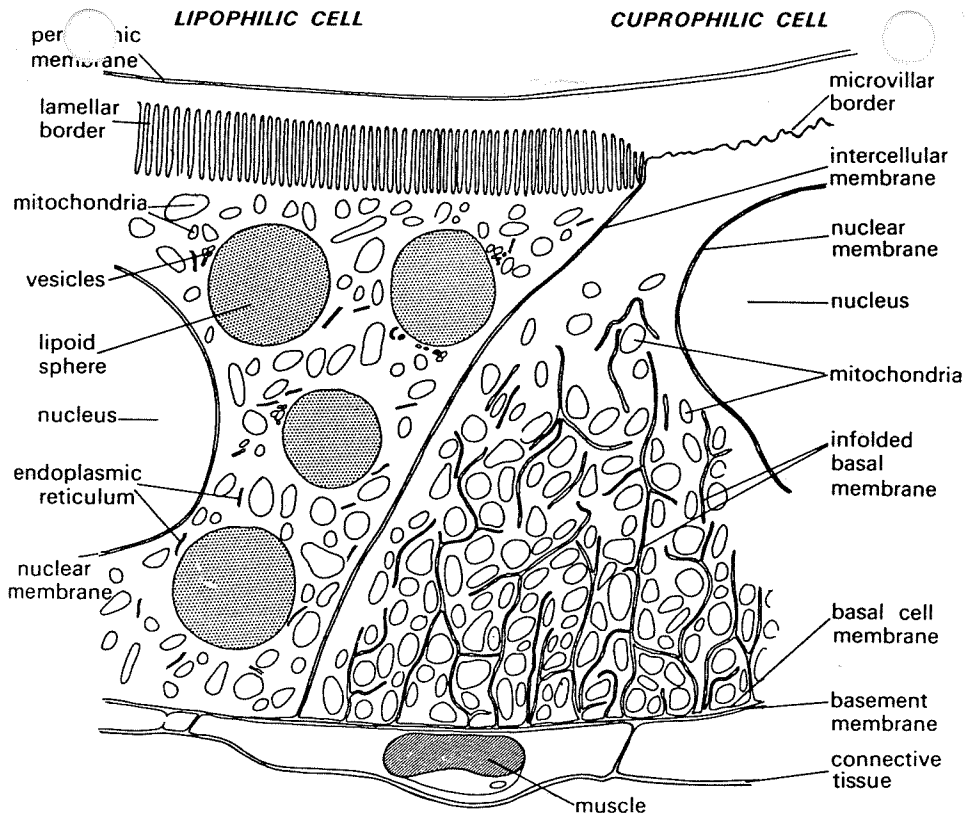


Fig. 33. Diagram of adjacent lipophilic and cuprophilic cells from the midgut of *Lucilia* larva (modified after Waterhouse and Wright, 1960).

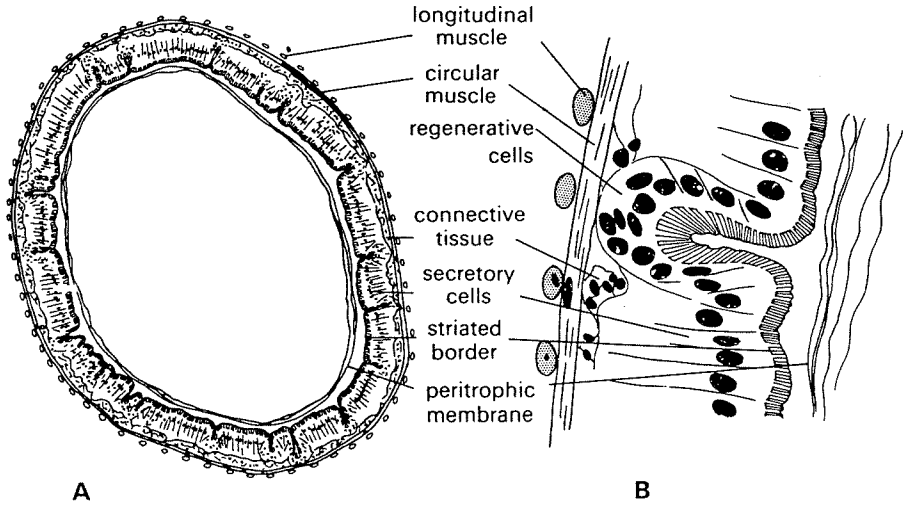


Fig. 32. A. Transverse section of midgut of *Chorthippus*. B. Section of midgut more highly magnified.

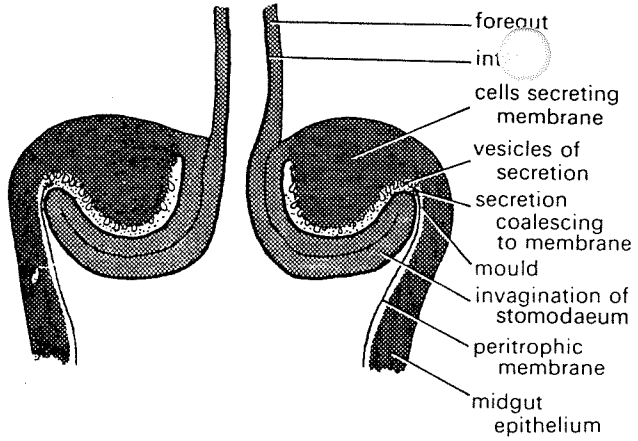


Fig. 36. Diagram of the junction of foregut and midgut in a dipteran showing the origin of the peritrophic membrane and the mould formed by the stomodaeal invagination and the midgut wall (modified from Wigglesworth, 1965).

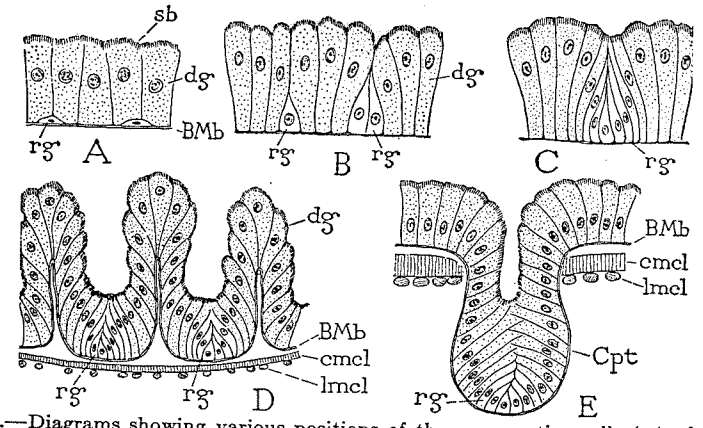


FIG. 202.—Diagrams showing various positions of the regenerative cells (*rg*) of the ventricular epithelium with relation to the digestive cells (*dg*).

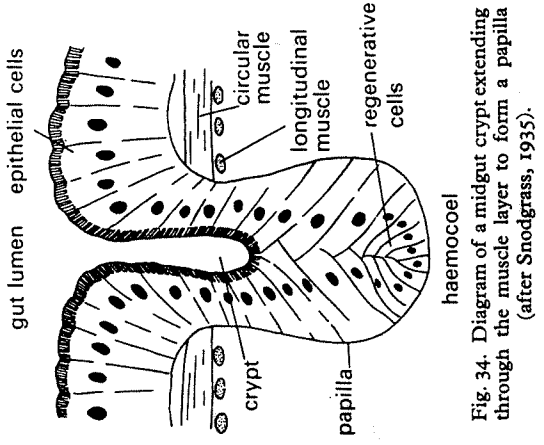


Fig. 34. Diagram of a midgut crypt extending through the muscle layer to form a papilla (after Snodgrass, 1935).

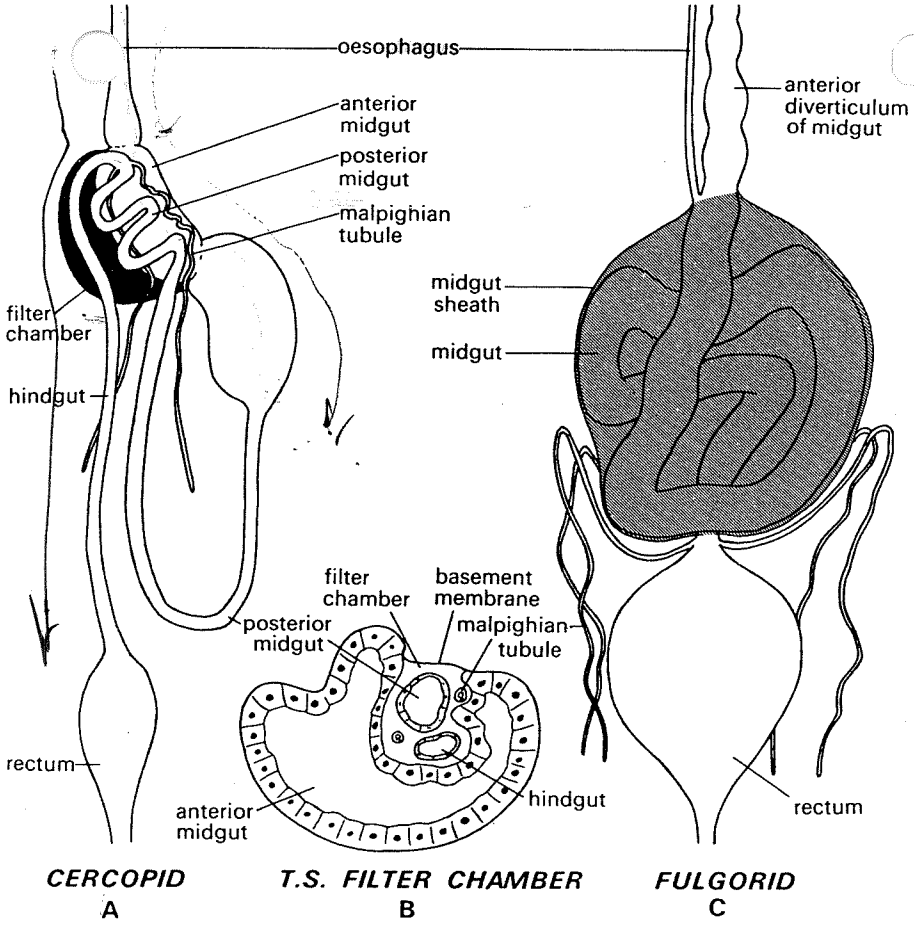


Fig. 35. A. Diagram of the alimentary canal of a cercopid showing the filter chamber (after Snodgrass, 1935). B. Transverse section of filter chamber (from Imms, 1957). C. Alimentary canal of a fulgorid (after Goodchild, 1963a).

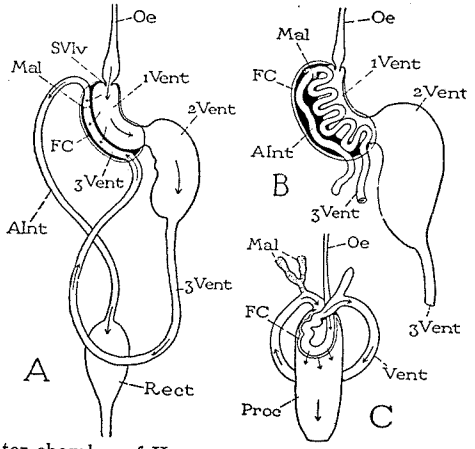


FIG. 209.—The filter chamber of Homoptera. A, diagram of a simple type of filter chamber in which the two extremities of the ventriculus and the anterior end of the intestine are bound together in a common sheath. B, the ventriculus convoluted in the filter chamber and the intestine issuing from its posterior end. C, the filter chamber of *Lecanium*, diagrammatic. (*From Weber*, 1930.)

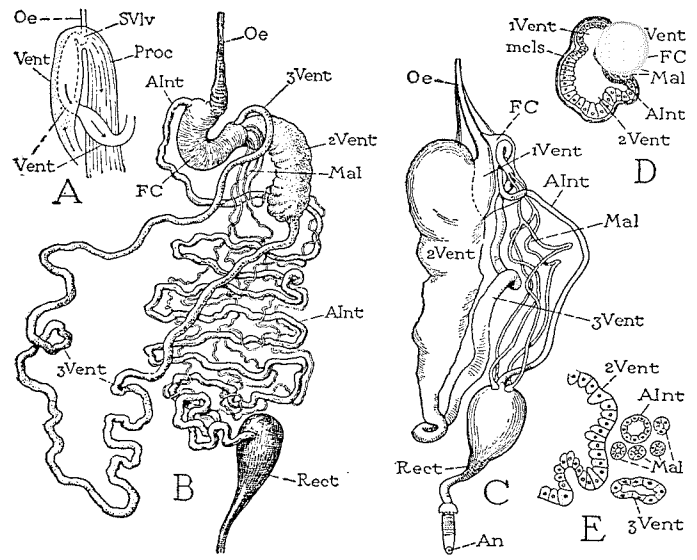


FIG. 210.—The alimentary canal and filter chamber of Homoptera. A, *Longistigma caryae*, the two extremities of the ventriculus and the upper end of the proctodaeum. (*From Knowlton*, 1925.) B, *Magicicada septendecim*, entire alimentary canal. C, *Tricentrus albomaculatus*, entire alimentary canal. D, same, section of filter chamber. E, same, section behind the filter chamber through two parts of ventriculus, anterior intestine, and Malpighian tubules. (C, D, E *from Kershaw*, 1913.)

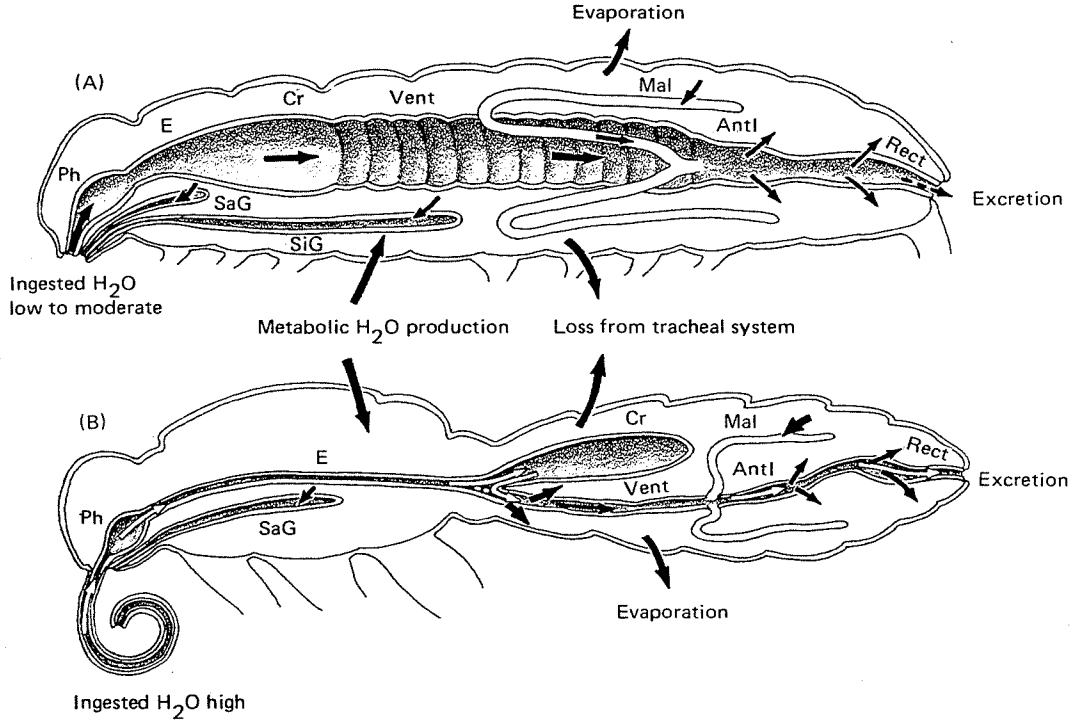


**Figure 59.** Movement of water into, around, and out of the body. (A) caterpillar ingesting solid food; (B) adult butterfly of the same species ingesting liquid food. Open arrows indicate high water content, black arrows moderate water content, and broken arrows low water content.

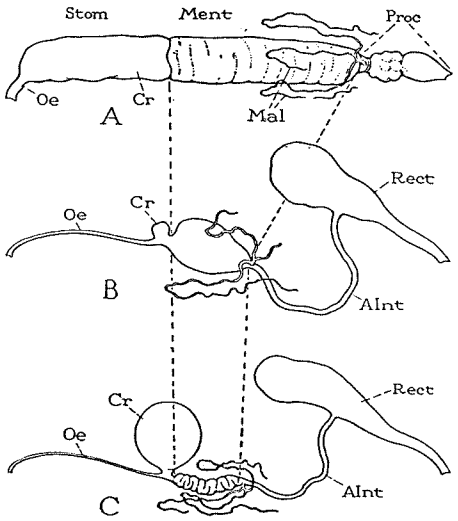


FIG. 197.—Transformation of the alimentary canal of a moth, *Malacosoma americana*, from the larva (A) through the pupa (B) to the imago (C).

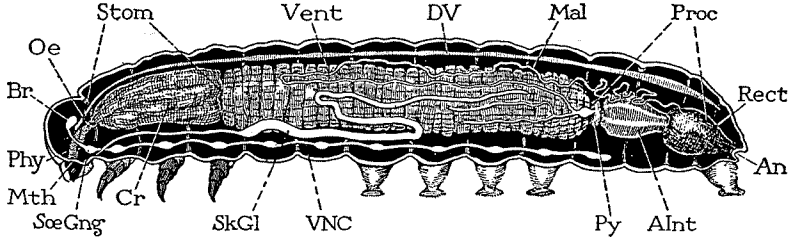


FIG. 196.—The alimentary canal, silk glands, dorsal blood vessel, and nerve cord of a caterpillar.

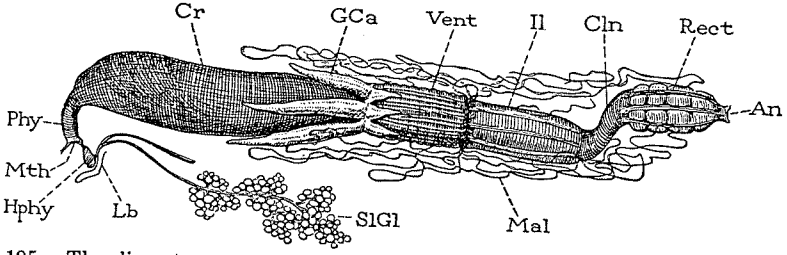


FIG. 195.—The alimentary canal, salivary glands, and Malpighian tubules of a grasshopper, *Dissosteira carolina*.

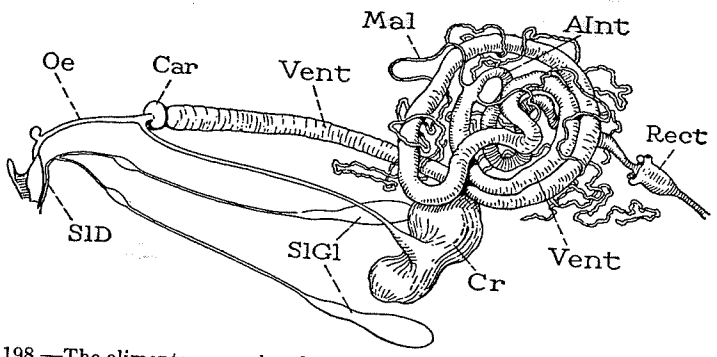


FIG. 198.—The alimentary canal and salivary glands of a fruit fly, *Rhagoletis pomonella*, showing the diverticular crop (*Cr*) and the cardiac sac (*Car*) of the ventriculus, characteristic of many Diptera.

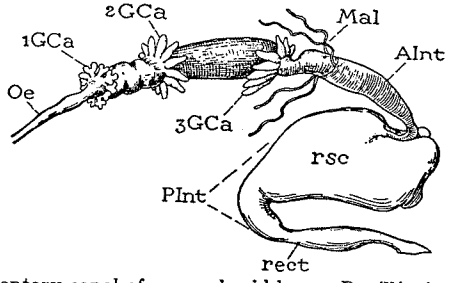


FIG. 199.—The alimentary canal of a scarabaeid larva, *Popillia japonica*, with three sets of gastric caeca (*1GCa*, *2GCa*, *3GCa*).