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A STUDY OF THE ANATOMY OF THE ALIMENTARY CANAL OF *BROCHYMENA QUADRIPUSTULATA* (HEMIPTERA:PENTATOMIDAE)

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ABSTRACT

An anatomical study of the alimentary canal and associated salivary apparatus was conducted for the pentatomid, *Brochymena quadripustulata*. The esophagus, ventriculus, pylorus, rectum, principal salivary glands and ducts are described and illustrated. Described structures of *Brochymena quadripustulata* are compared with various species of pentatomids and other hemipterans.

INTRODUCTION

Brochymena quadripustulata is one of the more common species of Pentatomidae in Northeast Arkansas. Except for studies of the gastric caecae conducted by Glasgow (1914), an extensive literature search failed to reveal studies of the internal anatomy of this hemipteran.

Previous studies of *Solubea pugnax* (Hamner, 1936), *Catacanthus incarnatus* (Ahmad and Afzal, 1978), *Murgantia histrionica* (Harris, 1936), *Peribalus limbolarius* (Glasgow, 1914), and *Chrysocoris patricius* (Kurup, 1963) were used for comparison and confirmation of the alimentary structures of *B. quadripustulata*. Studies of the coreids *Anasa tristis* (Breakey, 1936) and *Leptocoris trivittalus* (Glasgow, 1914) were also used for comparative purposes.

METHODS AND MATERIALS

Adults of *B. quadripustulata* were collected from mid-October through November 1979, in Craighead County, Arkansas. Live specimens were fixed in Bouin's solution for twenty-four hours and then stored in 70% ethanol until dissected. Specimens in the overwintering stage were collected from 9 January to 22 February 1980. These specimens were stored at 3-4°C until dissected, at which time they were anesthesized with chloroform. Esselbaugh (1948) reported that none of ten or more species of pentatomids placed in a refrigerator were able to survive, even though the specimens were not subjected to temperatures as low as they survive outdoors. We encountered no problems with mortality after refrigeration for periods up to two months with *B. quadripustulata*.

Access to the abdominal cavity and head capsule was facilitated by scissoring the flattened peripheral edge formed by fusion of the dorsal and ventral sclerites. Care was taken to clip the exoskeleton deeply enough to sever the wing bases, yet preventing damage to the internal organs. After trimming, the specimen was embedded in warm wax and covered with 70% ethanol. The scutellum was then removed by flexing it forward and pulling it outward. A similar procedure was used to free the pronotum. The tergum was removed by lifting its posterior edge up and forward. To expose the head capsule and its contents, the dorsal sclerites of the cranium were fragmented with forceps and removed in sections.

RESULTS

The alimentary canal of *B. quadripustulata* consists of a pharynx, esophagus, ventriculus divided into four regions, pylorus with paired malpighian tubules, rectum, and associated salivary structures.

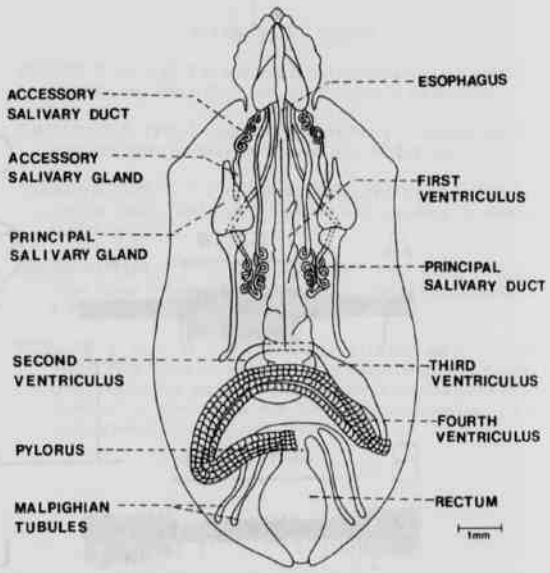

Figure 1. Dorsal View of the Alimentary Canal of *Brochymena quadripustulata*.

The esophagus consists of a long semi-transparent tube which extends from the anterior portion of the head passing between the circumesophageal connectives to approximately the middle of the prothorax (Fig. 1). The esophagus opens posteriorly into the ventriculus.

The ventriculus is divided into four distinct regions. Each region differs in length and contour. The first ventriculus appears as a large empty elongate sac which is thin walled with a rugose surface bearing a prominent dorsal raphe (Fig. 1). Specimens dissected *in vitro* under insect Ringer's exhibited peristaltic waves in this region. The second ventriculus follows as a long slender tube deflecting dorsally and then anteriorly to pass ventrally beneath the posterior region of the first ventriculus (Fig. 1). A gradual enlargement grades into the third ventriculus which appears to be the shortest region of the alimentary canal of *B. quadripustulata* (Fig. 2). It is a bulbous structure which constricts posteriorly to join the fourth ventriculus, composed of a tubular structure surrounded by four rows of gastric caecae arranged

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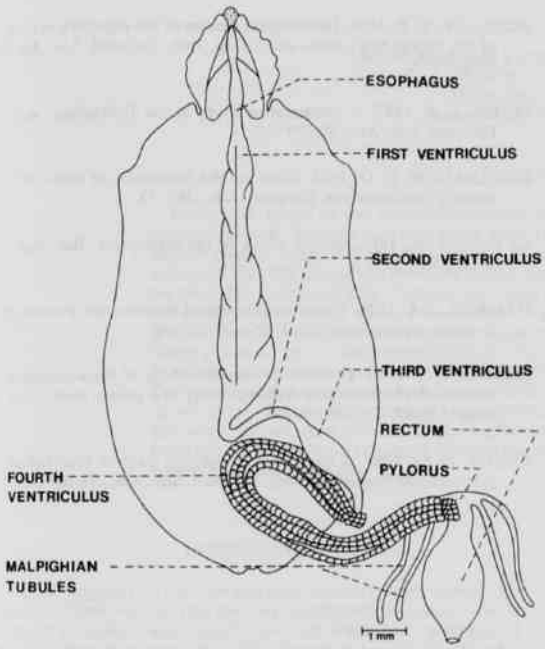

Figure 2. Dorsal View of the Alimentary Canal of *Brochymena quadripustulata* with Salivary Apparatus Removed and Parts Extended.

along its entire length (Fig. 1,2). The fourth ventriculus coils within the abdominal cavity and lies dorsally above the pyloric region with its posterior end connecting laterally to the pylorus (Fig. 1). Gastric caecae obscure this ventriculus from view (Fig. 1,2). The gastric caecae appear as uniform, sac-like structures which are closely set together.

The pylorus provides for attachment of the fourth ventriculus as well as for insertion of the malpighian tubules. It appears as a rounded knob-like structure with a pair of malpighian tubules attaching at each side of its anterior end (Fig. 1,2). The malpighian tubules float freely with the lower abdomen with some entwining around the ventricular regions before ending blindly. The posterior end of the pylorus constricts slightly at its juncture with the rectum.

The rectum is the posterior-most portion of the alimentary canal terminating with the anal opening. The rectal sac is a membranous structure which is dilated in the middle and then abruptly tapers into the anus (Fig. 1,2). The rectum was found to vary in size and shape from a small oval sac to an enlarged heart-shaped sac depending upon the amount of fluid it contained.

The associated salivary structures consist of principal and accessory glands and ducts. The two principal salivary glands are unequally bilobed and lie dorsad to the ventriculus in the thorax, the posterior lobes extending into the abdomen (Fig. 1). Each principal gland is provided with an accessory gland lying laterad and emptying by means of a long duct which extends into the head capsule. The duct retroverts into the abdomen, is directed anteriorly, undergoes a series of convolutions and finally opens at the juncture of the two lobes of the principal salivary gland (Fig. 1).

DISCUSSION

The typical hemipteran alimentary canal pattern was found to exist for *B. quadripustulata*. Comparison of this structure in other species of Pentatomidae and other selected Hemiptera resulted in similar anatomical patterns with the ventriculus comprising the largest part of the alimentary canal.

Since delineation of the pharynx and the esophagus was not anatomically feasible without histological investigation, the esophagus was chosen as the originating structure for this study of the alimentary canal as was also the case in the studies of Kurup (1963) and Ahmad and Afzal (1978). The tubular esophagus of *B. quadripustulata* was found to be moderately long gradually grading into the ventriculus. Studies by Hamner (1936), Harris (1936) and Breakey (1936) reported similar results while Ahmad and Afzal (1978) described an esophagus which terminated with an enlarged bulbous portion before passing into the first ventriculus. Studies by Ahmad and Afzal (1978) revealed the first ventriculus to consist of a small spherical anterior portion constricting to form a larger posterior suboval sac. No definite constriction was observed in *B. quadripustulata* which was found to be similar in structure to that of the coreid, *A. tristis* (Breakey, 1936).

The second ventriculus of *B. quadripustulata* was found to be relatively short, failing to comprise one-half the length of the alimentary canal as reported for *C. patricius* by Kurup (1963). In the specimens of *B. quadripustulata* studied, the majority had entered dipause and contained little or no food residue, thus the second ventriculus failed to display extensive dilation as reported by Breakey (1936) and Harris (1936).

According to Harris (1936), the third ventriculus is not a distinct region but regarded as a part of the second ventriculus because of the simimlarities of their histologies. However, Kurup (1963) regards the two regions as being distinct. In *B. quadripustulata*, an anatomical distinction between the two regions of the ventriculus appears to exist (Fig. 2), although no histological studies have been made to verify this.

The fourth ventriculus of *B. quadripustulata* appeared tubular bearing four rows of gastric caecae. The caecae have been studied in detail by Glasgow (1914) who found them to contain organisms which inhibit the growth of foreign bacteria in the mid-intestine. According to Elson (1937), the presence or absence of gastric caecae bears great importance from both a phylogenetic and nutritional point of view. *L. trivittalus*, a species which feeds chiefly on plants but occassionally on the fluids of animals, lacks gastric caecae (Glasgow, 1914). However, Breakey (1936) observed *A. tristis*, a strictly phytosuccivorous species, as having well-developed caecae arranged in two rows of closely set diverticula, whereas *B. quadripustulata* and all other species of pentatomids referred to in this study possessed four rows of gastric caecae.

The pylorus of *B. quadripustulata* compared favorably to that of *S. pugnax* (Hamner, 1936) yet differed from descriptions reported by Kurup (1963), Ahmad and Afzal (1978) and Breakey (1936). The malpighian tubules of *B. quadripustulata* were found to occupy the posterior portion of the abdominal cavity whereas Breakey (1936) described the tubules of *A. tristis* as extending into the caudal portion of the abdomen above the alimentary canal.

The rectum of *B. quadripustulata* was found to be consistent in structure with rectal sacs of other species of pentatomids and hemipterans; the anterior end of the rectum being formed by an extension of the pylorus and the posterior end tapering to form the anus.

The salivary glands of phytosuccivorous species may be differentiated in a general way from other groups by their complexity (Elson, 1937). The principal salivary glands studied in *B. quadripustulata* appeared as unequal bilobed structures, as was found in the studies of Ahmad and Afzal (1978) and Harris (1936).

The anterior lobes of the principal salivary glands in *B. quadripustulata* are broad based and extend anteriorly while the posterior lobes are tail-like and taper posteriorly ending bluntly. Hamner (1936), however, found the principal salivary glands of *S. pugnax* to have anterior lobes somewhat hand-shaped with four distinct finger-like projections on the anterior end. In many species, the principal salivary glands may be divided into several lobes or take on the appearance of clusters of grapes as reported by Elson (1937).

In insects which possess accessory salivary glands, a pair of ducts leads from the juncture of the two lobes of the principal glands; one duct leading to the accessory gland and the other to the salivary pump. This condition was observed in *B. quadripustulata*. Studies by Ahmad and Afzal (1978), Harris (1936), Hamner (1936) and Breakey (1937) also reported a comparable arrangement of the accessory glands and ducts.

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