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A MORPHOLOGY & HISTOLOGICAL STUDIES OF THE DIGESTIVE SYSTEM OF POECILOCERUSPICTUS

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ABSTRACT

Morphology & Histology Studied have done and author found significant result from the study The digestive tract Poeciloceruspictus has the usual three main divisions viz. stomodaeum or foregut, mesenteron or midgut and proctodaeum or hindgut.

KEYWORDS:*Morphology, Histology, digestive tract, Poeciloceruspictus*

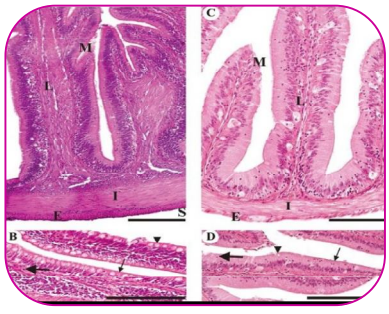
INTRODUCTION

The grasshoppers which belong to the family "Acrididae" have been reported as one of the most serious insect pests of certain important cultivated crops of India and other parts of the world causing heavy damage, but no accurate data is available on the extent of damage caused to various crops by different species of grasshoppers in India. Atwal (1965) has estimated a loss of about 500 crores of rupees annually of the total production of food grains in India only because of insects.

The grasshoppers, which also include the locusts of the world, due to their phytophagous habit, are the most destructive in the world. So much so, in the Chinese literature the locusts have been referred to as the famine carriers". Due to their harmful activities, they attracted the attention of man from the early times.

Sr.No.	GRASSHOPPERS	HOST-PLANT	FAMILY
1.	Poeciloceruspictus	Calotrapisgigantea (Linn.) (Hindi-AK) The leaf juice contains Milky latex and is often Used as a medicine.	Asclepiadaceae

As no work has been reported on the Morphology & Histology of the alimentary canal, such study was taken into consideration for present investigation. In spite of apparent similarity in the anatomical and histological details of the digestive tract, there are remarkable differences in their detailed structure.



MATERIALS & METHODS

Adult specimens of Poeciloceruspictus were collected from St. John's College campus. This is a common type of grasshopper and generally feeds on leaves of Ak. This is abundantly found in the month of July and August. This is dark green in colour. The systematic position is as follows:-

Class - Insecta
Order - Orthoptera
Family - Acrididae
Genus - Poecilocerus
Species - Pictus

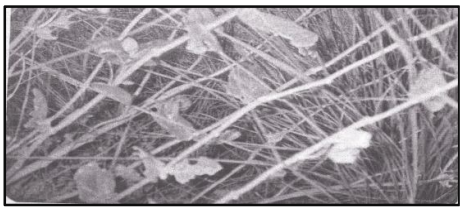
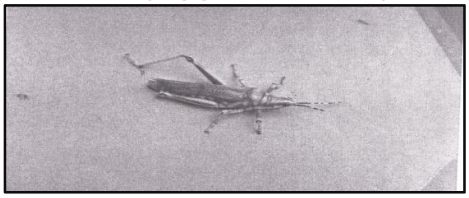


Figure:1A)Photograph of Calotropisgiganteathe host-plant of Poeciloceruspictus.



B)Photograph of Poeciloceruspictus.

For histological studied, the dissection were made and for dissection the grasshoppers were killed by putting them in potassium cyanide bottle. The grasshoppers were fixed in small dissection dishes containing paraffin wax of high melting point.

The dissections were performed in normal saline solution under stereoscopic binocular microscope with the help of a powerful electric lamp. For the histological studies the complete alimentary canal was dissected out from the body and fixed in aqueous bouin's fluid for 6-12 hours. The excess of picric acid was removed by washing in running water for 24 hours. The alimentary canal was thus cleaned with the help of a brush and fine needle and finally cut into different parts. The dehydration of the various parts of the gut was carried out in ethanol water series. They were cleared in cedar wood oil and then transferred into xylol and finally to a mixture of xylol and paraffin wax. Embedding was done in paraffin wax of 56^0-58^0C six hours and serial sections of 6-8 microns thickness were cut. The sections were stained in haematoxylin, counter stained with eosin, cleared in xylol and mounted in DPX.

Results

Morphology

The alimentary canal of Poeciloceruspictus is 56 mm. long and divisible into stomodaeum (Foregut), mesenteron (Midgut) and proctodaem (Hindgut). The length of foregut is 16mm. It includes a preoral cavity with the mouth surrounded by the mouth parts opening into very short mouth cavity of Pharynx. From it leads a short narrow and thin walled oesophagus, which enlarges into a thin walled sac, the crop, extending up to the posterior end of thorax. Below the crop are present a pair of branched salivary glands, ducts which open into the mouth cavity at the labium. Posterior to the crop is the short grinding organ, the proventriculus or gizzard, lined with chitinous plates and teeth.

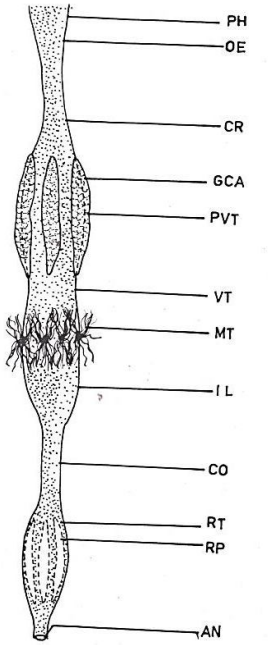


Figure 2: Alimentary Canal of Poeciloceruspictus

ABBREVATIONS

AN - Anus
CO - Colon
CR - Crop
GCA - Gastric caeca
IL - Ileum
MT - Malpighian Tubules
OE - Oesophagus
PH - Pharynx
PVT -Proventriculus
RP - Rectal papillae
RT - Rectum
VT - Ventruiculus

The midgut is 28 mm. long starting from gizzard, it includes ventriculus or stomach, which reaches posteriorly into the abdomen. It is lined by a peritrophic membrane which is fully permeable to enzymes. Opening into the anterior end of stomach is a ring of 6 pairs of elongated, cone-shaped pouches called the gastric caeca. The length of hindgut is 12 mm. Its junction with stomach is marked by attachment of numerous long malpighian tubules. The uncoiled intestine consists of an anterior tapered ileum, a slender middle colon and a posterior rectum, which opens to the exterior through the anus. (Fig. No. 2)

Histology

The grasshoppers exhibit typical histological features of the digestive tract of the order orthoptera. It consists of three parts via. Stomodaeum or foregut, mesenteron and proctodaeum or hindgut. The wall of the digestive tract is made up of four layers. In stomodaeum and proctodaeum, there is outer circular muscle layer, followed by longitudinal muscle layer and epithelium resting on the basement membrane with the inner chitinous lining, the intima, but in the region of mesenteron the outer layer consists of longitudinal muscles followed by circular muscles and epithelium, the intima is not present in this region.

The histology of the digestive tract of the following three grasshoppers have been studied:

Stomadeum:

Histologically the stomodaeum or the foregut is differentiated into pharynx, oesophagus, crop and proventriculus.

Pharynx:

The innermost layer of pharynx is the chitinous intima. It is thick and entirely devoid of spines or bristles. External to intima lies the epithelial layer. The cell boundaries of the epithelial layer are not differentiated. Its nuclei are oval to round and cytoplasm is finely granular. The intima of the epithelium is folded. It lines six longitudinal folds. One of the longitudinal fold is conspicuously larger than the others. The epithelium is surrounded by the muscularis, composed of circular muscles fibres arranged in single layer. The longitudinal muscles are present in the form of bundles lying at the base of the longitudinal folds.

Oesophagus:

Histologically the oesophagus shows the same fundamental arrangement as that of the pharynx. The chitinous intima is comparatively thin. It is smooth and devoid of spines or bristles. The epithelium consists of flat cells with indistinct cell walls. The cytoplasm of cells is finely granular or with well-defined oval nuclei. The intima of the epithelium is folded and lines the longitudinal folds. The number of longitudinal folds increases in comparison to pharynx. There occur extending into the lumen of the oesophagus throughout. The musculature consists of two to three layers of circular muscles. The longitudinal muscles are observed in the form of bands lying at the basis of the longitudinal folds.

Crop:

The crop is a straight tube greater in diameter than the pharynx and oesophagus. The intima is smooth and devoid of spines or bristles. The epithelium is syncytical and the nuclei are large, oval and distinct. The cytoplasm is finely granular. The epithelium forms numerous, narrow, longitudinal folds almost equal in length. They do not project much into the lumen and increase the lumen of the crop to a great extent. The musculature is very well developed. The circular muscles consists of three to four layers. The longitudinal muscles are observed in the form of well-developed separate bundles at the basis of the longitudinal folds.

Proventriculus:

It is structurally the most highly specialized part of the digestive tract. The intima is very well developed. It is provided with spines. The intima is followed by an epithelial layer. The cell boundaries of the epithelial layer are not differentiated. Its nuclei are oval and distinct. The cytoplasm is finely granular. Both the epithelium and the intima are folded to form characteristic six V-shaped proventricular plates. These plates are arranged equidistantly in the lumen. The muscularis is comparatively less developed. There is only a single layer of circular muscles. The longitudinal muscles are present in the form of bundles outside the circular muscle layer and at the bases of the longitudinal folds.

Mesenteron:

The mesenteron shows the absence of intima. The inner most layer consists of epithelium. It is composed of two types cells (1) Columnar cells (2) Regenerative cells. The columnar cells are more distinct towards the posterior part of the mesenteron is mainly constituted by a large number of columnar cells. These cells possess distinct cells walls and their bases rest on the basement membrane. The nuclei of the columnar cells are prominent and more or less centrally placed. The cytoplasm is granular. The dimension of the columnar cells depends on the age of development and the degree of contraction and relaxation of the mesenteron wall. The columnar cells are provided with striated border of variable height. The columnar cells discharge the secretion uniformly into the lumen of the mesenteron.

The regenerative cells occur at the base of the epithelial folding. These cells are small and somewhat triangular in shape having distinct nuclei. The function of these cells is to replace the degenerative cells by their active division.

The musculature is composed of three to four layers of circular muscles. The peritrophic membrane is absent.

Proctodaeum:

The proctodaeum or the hindgut is divisible into ileum, colon and rectum.

Ileum:

The intima is relatively thin and soft. Epithelium is made of cuboidal cells with small, rounded nuclei and granular cytoplasm. The epithelium forms twelve longitudinal folds which are well developed and extend quite deep into the lumen. The musculature is composed of two layers of circular muscles. The longitudinal muscles are present on the innerside of the circular muscles at the bases of the longitudinal folds.

Colon:

The intima is thick and smooth. The epithelium consists of small cuboidal cells which distinct cell walls. The nuclei are large and oval. The cytoplasm of epithelial cells is finely granular. The epithelium is thrown into longitudinal folds and the chitinous intima also bends sharply with the epithelial folds. The longitudinal folds are projecting into the lumen. The number of longitudinal folds is ten. The musculature is well developed. There are two layers of circular muscles. The longitudinal muscles are observed at the bases of the longitudinal folds on the inner side of circular muscles.

Rectum:

At the termination of the colon, the proctodaeum is continued as rectum. The rectum opens to the exterior through the anus. The rectum is in the form of a thick walled narrow tube anteriorly as broad as the colon. The epithelium is raised into six longitudinal folds, the rectal pads. The rectal pads are not continuous but are interrupted by grooves. They are composed of a single layer of long columnar cells. The boundaries of the columnar epithelial cells are distinct. The cytoplasm is finely granular and contain centrally placed nuclei. Each rectal pad is elevated on the side towards the lumen of the rectum. The chitinous intima is very thin over the surface of each rectal pad and does not possess any spicule and is widely separated from the epithelium. The musculature consists of an inner circular muscle layer and outer longitudinal muscles arranged in six bundles.

DISCUSSION

The present discussion is based on the authors studies on the histology of the digestive tract of Poeciloceruspictus. On the anatomical bases, Snodgrass (1935) divided the digestive tract of the insects into three major regions, namely stomodaeum or foregut, mesenteron or midgut and proctodaeum or hindgut. The digestive tract of Poeciloceruspictus showed three major divisions of the gut. Similar observations were made by Hsu (1931) in Gryllusmitratus, Hodge (1939) in Locustamigratoria, Walker (1949) in Gryllotalpacampodesformis.

In general, the stomodaeum consists of buccal cavity, pharynx, oesophagus, crop and proventriculus and mesenteron of gastric caeca and ventriculus and proctodaeum-consists of ileum, colon and rectum. Rajan (1956) in mantis spp. reported the absence of pharynx and described the alimentary canal to be made of oesophagus, proventriculus in Poeceiloceruspictus .Chatuvedi (1983) also reported the bristle-less intima in the pharynx of Acridagigantia. Under the present investigation the spines on bristles are entirely absent on the chitinous intima of pharynx in Poeciloceruspictus.spines are absent on the intima of oesophagal region in Poeciloceruspictus and also reported by Saxena (1965) and Chaturvedi (1983) in Acridagigantia.

The crop is an enlargement of the posterior part of the oesophagus. It acts as a storage organ or reservoir for the food material in general but in some cases its function is specialized due to the nature of food material. In Poeciloceruspictus the wall of the crop is better developed, than that of oesophagus and the lumen increases to a great extent due to the presence of numerous epithelial folds to accommodate large quantity of food material side by side. The thickness of the chitinous intima decreases considerably and facilitates the churning of food material. The spines are absent on the intima of crop region in Poeciloceruspictusas reported by Saxena (1965) in Gryllodessigillatus and Singh (1965) in Chrotogonus species.

The author is of the opinion that the proventriculus in Poeciloceruspictusacts as a sphincter between the crop and the mesenteron to regulate the onward passage of food into the mesenteron. It is also acts as an inefficient strain. The proventricular teeth bring about pulverizing the hard material in the food to some extent.

The author observed the presence of spines or bristles on the chitinous intima of the proventricular plates in PoeciloceruspictusSimilar observations were made by Tietz (1923) in Dissorteiria Carolina, Srivastava (1981) in Gryllotalpagryllotalpa and Chaturvedi (1983) in Schizodactylusmonstrosus. But the spines have not been observed on the chitinous intima of the proventriculus in Chrotogonustrachypterus. Hodge (1939) in Locustamigratoria and Singh (1965) in Chrotogonus species also observed the complete absence of spines or bristles on the chitinous intima of the proventriculus

In Poeciloceruspictus the epithelial cells are elongated, columnar with large rounded to oval nuclei. The epithelial cells are of two types:- The functional epithelial cells and the regenerative cells. The former are elongated, columnar cells are with torn boundaries and striated border and are secretive or absorptive in function, while the later are small and arranged in dome-shaped manner and replace the torn functional epithelial cells. These observations are in accordance with that of Narula (1971) and Chaturvedi (1983). Snodgrass (1935) described that the digestive cells are of uniform structure throughout the mesenteron but they may be different sizes or may be found in various stages of disintegration.

The columnar cells possess a striated border. The nature of the striated border has been the subject of discussion. Earlier investigators believed it to be a coating of fine filaments covering the inner surface of the stomach comparable to with the ciliate lining of the mesenteron in Annelida.

At the distal ends of many full sized and old columnar cells, the globular protrusions or vesicles have been observed in the lumen of the gut. Shinoda (1927) regarded these structures as secretion vesicles. Invariably finding the cells broken up into the lumen of the mesenteron, the author feels the nature of secretion is holocrine in the grasshoppers under investigation.

In the present investigation the peritrophic membrane has not been observed in Poeciloceruspictusas reported by Cuenot (1895) and Sayce (1899) in Gryllotalpa.

The finely ground food material passes through the mesenteron as a homogenous paste which is subjected to the action of digestive fluids secreted by the mesenteron epithelium. Absorption of the nutrients presumably occurs simultaneously in the mesenteron.

Histologically the proctodaeum bears close resembles with the stomodaeum only with minor variations. Its wall is similar to stomodaeum. Inner chitinous intima is thinner and more permeable than that of the stomodaeum. The proctodaeum is divisible into three regions ileum colon and rectum.

In Poeciloceruspictus the ileum is thin walled as compared to mesenteron. Its epithelium forms plate like folds. The colon is of lesser diameter than the ileum. It is comparatively a thick wall tube. The epithelium is thrown into large number of folds, which project deep into the lumen. In the rectum of these grasshoppers, the epithelium is provided with six rectal pads as described by Hodge (1936) in Melanoplusdifferentialis.

The protodaeum is an exclusively absorptive part of the digestive tract. The digested food contents are absorbed through the surface of the epithelial cells. The epithelial cells apparently do not increase in number either through division or through development form regenerative cells.

CONCLUSION

The wall of the different regions of the digestive tract is made up of four layers. In stomodaeum and proctodaeum there is outer circular layer, followed by longitudinal muscle layer and epithelium resting on the basement membrane with the inner chitinous lining, the intima but in the region of the mesenteron the outer layer consists of longitudinal muscles followed by circular muscles and epithelium, the intima is not present in this region. The stomodaeum is differentiated into pharynx, oesophagus, crop and proventriculus. In all the grasshoppers under study the spines or bristles are entirely absent on the chitinous intima of the pharynx. The spines are absent on the intima of oesophageal region in Poeciloceruspictus. The histological structure of the crop of all the grasshoppers under study reveals that the chitinous intima lines and all the longitudinal folds are devoid of spines or bristles.

The chitinous intima of the proventriculus lines and the six longitudinal folds form the six proventriculus plates. The intima of Poeciloceruspictus bears spines. The proventriculus plates mastricate the hard food material into very fine particles for the action of digestive fluids to react in the mesenteron. The proventriculus in Poeciloceruspictus, also serves as a regulatory valve for the passage of food from the crop to the mesnteron.

The mesenteron consists of long columnar cells with regenerative cells lying towards the bases of the columnar cells. The holocrine type of secretion has been observed in the mesenteron of Poeciloceruspictus.

The proctodaeum consists of the ileum, colon and the rectum. The wall of the proctodaeum is similar to that of the stomodaeum. InPoeciloceruspictus the ileum is thin walled as compared to the mesenteron. Its epithelium forms plate like folds. The colon is of lesser diameter than the ileum.

The epithelium is thrown into large number of longitudinal folds which project deep into the lumen. Inner chitinous intima is thinner and more permeable than that of the stomodaeum. In the rectum of these grasshoppers the epithelium is provided with six rectal pads. The chitinous intima is very thin over the surface of each rectal pad and widely separated from the epithelium. The intima is devoid of spines.

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