Histology of the Stomach of the Common Green Snake, *Thamnophis sirtalis*

Lois Doerfler

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HISTOLOGY OF THE STOMACH OF THE COMMON GREEN SNAKE, THAMNOPHIS SIRTALIS

Methods and Materials

Observations

I. Mucosa
II. Submucosa
III. Muscular
IV. Serosa

Summary

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INTRODUCTION

This is another in the series treating the histology of the digestive tract of the reptile. Very little comparative work has been done on the digestive system as a whole and less attention has been paid to the stomach. Kendall (1935) and other writers have given some slight discussion to a general histology of the stomach. The following report is a detailed microscopic investigation of the stomach of the common species of the common species. The food of the common water snake, Natrix natrix, consists of frogs, toads, and salamanders. The snake inhabits the vicinity of ponds, lakes, and streams where it preys on smaller amphibious. The material used for this investigation was taken from three recently sized specimens (24-30 inches in length). The first was killed within a few days after its capture and the second had been without food for several days before it was killed. One of the specimens is unusual and interesting in that the contents surround the entire posterior portion of the stomach. The entire stomach consisted of the esophagus to the pyloric valve and sub-rectal segments which were fixed in either potassium dichromate, Benson's, formalin, Bouin's, or Zenker's. Dehydration was carried out with iso-amyl alcohol in the usual manner. All sections were made at fifteen micra and were stained in either Thielich's haemotoxyline, Dres.
INTRODUCTION

This is another in the series treating the histology of the digestive tract of the reptile. Very little comparative work has been done on the digestive system as a whole and less attention has been paid to the stomach. Kendall (1940) and Cole (1941) devote a slight discussion to a general description of the reptilian stomach. The following report is a more detailed microscopic investigation of the anatomy of the stomach of one of the common species of snakes.

The food of the common garter snake, Thamnophis sirtalis, consists mainly of frogs, toads, and salamanders. The snake inhabits the vicinity of ponds, lakes, and streams where it preys on smaller amphibia. The material used for this investigation, was taken from three medium sized specimens (24-30 inches in length). The first was killed within a few days after its capture and the second had been without food for several days before it was killed. One of the specimens is unusual and interesting in that the duodenum surrounds the entire posterior portion of the stomach. The entire stomach posterior from the esophagus to the pyloric valve was cut into segments which were fixed in either potassium dichromate, Ranson's, formalin, Bouin's, De Fainc's, or Zenker's. Dehydration was carried out with iso-amyl alcohol in the usual manner. All sections were made at fifteen micra and were stained in either Ehrlich's haemotoxylin, Iron
A microscopic study of the stomach of Thamnophis, shows that it bears an essential relationship to the stomach of the vertebrates in general. There are the four usual coats: the mucosa, the innermost layer facing the lumen itself; the submucosa, beneath it; the muscularis; and the outermost layer, the serosa. Each of these regions will be treated in the order just mentioned.

MUCOSA

The inner layer of the stomach wall, the mucosa, is composed of simple columnar epithelium. The mucosa is thrown into a series of folds, or rugae, which lie in longitudinal folds as well as in transverse folds. The longitudinal folds are far more conspicuous and taller than the transverse folds. However, the transverse folds are in most cases as complex as the longitudinal folds, although they are fewer in number. The folds do not fill the lumen completely. The number and density of the rugae remain somewhat the same throughout the entire length. The longitudinal folds measure 300-800 micra and the transverse folds measure 50-300 micra.

The simple epithelium covering the surface of the stomach contains three types of cells; simple columnar
epithelium, goblet cells, and wandering lymphocytes. The columnar cells are of nearly equal thickness and they have an average height of 32-40 micra. The nuclei are elongated and they contain coarse granules. They measure 6-8 micra in length. A striated border is only conspicuous in the epithelium above the goblet cells.

Wandering lymphocytes are found in all portions of the epithelium. They measure 4 micra in diameter. They are clearly distinguishable from the nuclei of the columnar cells because they are smaller, more rounded and they stain more deeply than the epithelial nuclei.

The goblet or mucous cells arise from the simple columnar epithelium and the transition from columnar cell to goblet cell is clearly observed. Goblet cells are only present in greater numbers in the most anterior portion of the stomach. The fully formed goblet cell has the characteristic oval shape with a slender basal end. The cytoplasm is distinctly granular. Particles of mucigen protrude from some cells and produce a distinct plug. Incompletely developed cells have a well defined striated top plate. In regions where goblet cells are present, the number is not so exceedingly high that they completely displace the columnar cells.

TUNICA PROPRIA

The tunica propria extends from the epithelial

of these cells and the mucous glands would identify this
membrane to the muscularis mucosae. Its width varies depending upon the region. The variation is 50-140 micra.

In the most anterior region the tunica propria is so scant that it is hard to recognize, but its width increases through the remaining middle and posterior regions. In these two places it becomes very prominent.

Gastric crypts are easily visible. They are small pits which are lined with simple columnar epithelium and they are found beneath the epithelium. The presence of different types of glands makes it possible to divide the stomach into the customary three portions comparable to similar regions of higher vertebrates: the cardiac, the fundic, and the pyloric regions.

The first portion of the stomach, the cardiac, is characterized both by the tunica propria and the glands. This region is the longest of all three portions. Its width measures approximately 16 micra. The tunica throughout this area is very scanty. This sets it off very noticeably from the other regions. Similarly, the glands to be found here are characteristic.

The glands in this region are very few in number. The cells which make up the glands are made up of mucous cells. The glands are small and they have a short excretory duct, and they can be seen leading into the epithelium. They measure 8 micra in diameter. A few parietal and chief cells are present. The presence of these cells and the mucous glands would identify this
region as the cardiac region. It is comparable to the cardiac region of the stomach of the mammalian.

The next region, or the middle portion, corresponds to the dundic region. Glands, resembling fundic glands found in the mammalian form, are present. They are distinctly different from those found in the anterior region. These are glands of a simple tubular type, and they are very numerous and compact. The glandular portion of the gland is quite long and it terminates in a mucous end piece. In many cases, the dilated end pieces can be seen leading into the epithelium. In number and size, these glands differ greatly from the glands found in the anterior portion. In this portion of the stomach, chief and parietal cells are present. The chief cells are wedge shaped and they have large nuclei. The cytoplasm has a granular appearance. The parietal cells are larger and lighter staining. They are greater in number than those present in either the anterior or posterior regions. The increase of the number of these cells and the difference in the type of glands found here, makes the middle portion comparable to the fundic portion of the mammalian stomach. The glands measure 28 micra in diameter.

The third definitely defined region is the most posterior region. The glands present are different from the two preceding regions. They have become distinctly more
mucous in appearance, and the end pieces have become larger. The long glandular portion has become much shorter and in the more distal portion it has disappeared. The glandular portion measures 110 micra in diameter and the mucous end pieces measure 40 micra. Very few parietal cells are present. The transition of glands from the anterior to the middle region is more abrupt and marked than the transition of glands from the middle to the posterior region.

The transition of each of these regions is clearly distinguishable, although it is gradual, and each is a separate and distinct region of the stomach.

The tunica propria surrounds the glands. Small blood vessels, arteries and veins, are found in the tunica propria. Erythrocytes, which may have escaped from the blood vessels, are found among the glands. Fine strands of muscle fibers are found in the tunica propria and these are mingled with the connective tissue. Their presence is brought out clearly by staining. Lymphocytes as well as lymph nodules are found here. The latter are situated well up in the folds. They have no definite structure but instead they are spread over the ends of the folds. They vary in size and shape.
MUSCULARIS MUCOSAE

The muscularis mucosae extends from the tunica propria to the submucosa. In the stomach it is distinguishable throughout. However, in the most anterior region, the muscularis mucosae is very thin and hardly evident. The thickness increases and it reaches its greatest width in the most posterior portion. It consists of two layers, an inner circular layer and an outer longitudinal layer. The thickness of the muscularis mucosae varies from 8 micra to 24 micra as it progresses from the anterior to the posterior region.

SUBMUCOSA

The submucosa reaches its greatest density in the folds. It extends from the muscularis mucosae to the muscularis. Generally it is scanty and hardly evident between the two layers. In most cases it is distinguishable from its adjoining layers. The submucosa measures 35 to 90 micra.

The submucosa is made up of collageneous connective tissue. In it are seen the nuclei usually found in collageneous tissue. Blood vessels are very numerous in this region. Lymph nodules which were found in the tunica propria continue through the muscularis mucosae and are found in the submucosa. Lymph nodules of definite shape are present at the base of the folds, some being
slightly triangular and the apex extends into the folds. Other nodules are spherical in shape. Nerves are also found. The cytoplasm is clearly stained and the nuclei are dark and granular in appearance. They are the neurons of Meissener's Plexus.

**MUSCULARIS**

The external muscle layer consists of two layers of smooth muscle fibers, an outer longitudinal layer and an inner circular layer. The layers are separated by a thin partition of connective tissue in which the neurons of Auerbach's Plexus are recognizable. In several cases the muscularis is so undeveloped that it is extremely thin or it disappears altogether. In general the customary muscularis is present. At times the longitudinal and circular layers appear to have exchanged places; they are reversed. This reversal is probably due to fixation.

The outer longitudinal layer is continuous around the stomach. In many instances it is thrown into a series of folds so that it appears wavy. The fibers which are usually parallel to the long axis of the tube have become perpendicular to the stomach cavity. This condition may be due to the shrinking of the muscle upon fixation. Towards the pyloric portion of the stomach, the longitudinalis becomes much thicker than it was in the anterior portion. It is more pronounced and more definite
in the posterior portion.

The circular layer is the most conspicuous muscle layer. Like the longitudinal muscle, it increases in thickness from the anterior to the posterior regions. In the posterior region the muscle fibers are arranged diagonally. This is noticed particularly in the region of the pyloric sphincter. Otherwise the fibers are customarily arranged and well developed. There is no inner oblique layer except where sections are so cut that the circular appears to be oblique.

In a cross section the longitudinal muscle fibers are arranged in definite bundles. The nuclei of the bundles are very prominent. The longitudinal muscle layer varies slightly from dorsal to ventral side. The condition prevails generally, except in the undeveloped side. It is greater in width in the dorsal side and narrower on the ventral side. The circular layer follows the longitudinalis in thickness. The variation is shown in the tables as well as the variations of the other layers of the stomach.

<table>
<thead>
<tr>
<th></th>
<th>Anterior</th>
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<th>Middle</th>
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<td>70</td>
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<td>90</td>
<td>50</td>
<td>90</td>
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</tbody>
</table>

The thickness in micra of dorsal and ventral walls in anterior, middle, and posterior regions.
SEROSA

The serosa, the outermost portion of the stomach wall, consists of a single layer of mesothelium and a greater sub-serous area of fibrous connective tissue. Within the connective tissue are found many blood vessels which penetrate into the submucosa, and a few lymph nodules. The presence of these increases the size of the serosa considerably, particularly on the dorsal side of the stomach. There is no noticeable increase in the thickness of the serosa from the anterior to the posterior regions.

4. The submucosa is evident in all portions of the stomach.

5. The muscularis is arranged in the customary longitudinal and circular layers.

6. A myenteric plexus is situated in the connective tissue between the two muscle layers.

7. External to the muscularis is the serosa which consists of a thin layer of mesothelial cells and a subserous layer of connective tissue.

8. Blood vessels penetrate the serosa and continue through all layers into the folds of the mucosa.
SUMMARY

1. The stomach wall of Thamnophis sirtalis consists of four main coats: mucosa, in which are present a tunica propria and a muscularis mucosa; submucosa; muscularis; and a serosa.

2. Columnar, goblet and wandering lymphocytes make up the mucosa. Goblet cells are derived from columnar epithelium.

3. The tunica propria fills up the spaces between the folds the mucosa. In it are found three types of glands comparable to the glands of the three portions of the mammalian stomach.

4. The submucosa is evident in all portions of the stomach.

5. The muscularis is arranged in the customary longitudinal and circular layers.

6. A myenteric plexus is situated in the connective tissue between the two muscle layers.

7. External to the muscularis is the serosa which consists of a thin layer of mesothelial cells and a subserous layer of connective tissue.

8. Blood vessels penetrate the serosa and continue through all layers into the folds of the mucosa.
BIBLIOGRAPHY


Approved

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Dean

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