

S U M M A R Y  
A N D  
C O N C L U D I N G R E M A R K S

A critical analysis of the existing literature shows that the mucosubstances have been studied mainly in the connective tissue, cartilage and epithelia. In addition these have also been studied in the respiratory tract, reproductive tract, nervous system, kidney, salivary glands, lingual glands etc. Comparatively less attention has been paid to the alimentary tract mucosubstances. Although the mucosubstances have also been studied in the gastrointestinal tract, the mammals are the focal point for such studies and particularly the laboratory animals. In this regard the various organs of the alimentary tract of the submammalian vertebrates have not received the due attention as they rightly deserve.

Norris (1959) reported that although several descriptions of the frog's gastric mucosa were published before the turn of the century, a search of the subsequent literature disclosed no comprehensive report based on more recent staining methods. Recently, Loo and Wong (1975) have pointed out that "The survey of the literature reveals that very little has been published on the mucins of the gastrointestinal tract in Anurans." This stimulated to undertake the present investigation on mucosubstances in the alimentary tract of the frog, E. systoma. Several well established histochemical techniques were employed in the present investigation.

The following is a brief summary of the observations and conclusions drawn in the present investigation.

#### I) Esophagus

- 1) The esophagus consisted of mucosa, submucosa, muscularis

and serosa. The epithelium contained columnar epithelial cells and two types of goblet cells( type - I and type - II cells ). The glands also contained type - I and type - II cells.

- 2) There is no sexual dimorphism in the esophagus.
- 3) The mucosubstances in the various histological sites of the esophagus resembled in their histochemical reactivities to the identical mucosubstances in other organ-systems.
- 4) The histochemical results revealed the presence of neutral mucosubstances in columnar epithelial cells and serosa; neutral mucosubstances, sulfomucins and sialomucins in type - I goblet cells and type - I cells in glands; neutral mucosubstances and sialomucins in type - II goblet cells and type - II cells in glands; neutral mucosubstances and hyaluronic acid in the connective tissue and glycogen in muscularis.
- 5) Some of these mucosubstances are similar to the esophageal mucosubstances in other vertebrates.
- 6) Protection of the mucosa and lubricating functions have been suggested to the secreted mucosubstances in the esophagus.

## II) Cardiac stomach

- 1) The cardiac stomach consisted of mucosa, submucosa, muscularis and serosa. The epithelium contained columnar epithelial cells and goblet cells. Mucous glands are seen in

the proximal part. The gastric glands contained deeper cells (oxyntic cells) and mucous neck cells.

- 2) There is no sexual dimorphism in the cardiac stomach.
- 3) The mucosubstances in various histological sites of the cardiac stomach resembled in their histochemical reactivities to the identical mucosubstances in other organ-systems.
- 4) The histochemical results indicated the presence of neutral mucosubstances in columnar epithelial cells; neutral mucosubstances, sulfomucins and sialomucins in goblet cells; neutral mucosubstances and sulfomucins in mucous glands; neutral mucosubstances in mucous neck cells; neutral mucosubstances in serosa and absence of mucosubstances in deeper cells of the gastric glands.
- 5) Some of these results are in good agreement with the mucosubstances reported in the cardiac stomach of other vertebrates.
- 6) Some of the functions such as lubricant, protection of mucosa, buffer against gastric acidity and antipeptic activity of mucosubstances have been discussed and suggested.

### III) Pyloric stomach

- 1) The pyloric stomach consisted of mucosa, submucosa, muscularis and serosa. The surface epithelium was formed exclusively of goblet cells. Pyloric glands were also seen.
- 2) There is no sexual dimorphism in the pyloric stomach.

- 3) The mucosubstances in the various histological sites of the pyloric stomach exhibited tinctorial affinities similar to those exhibited by identical mucosubstances in other organ-systems.
- 4) The histochemical results indicated the presence of neutral mucosubstances in epithelial goblet cells, pyloric glands and serosa; neutral mucosubstances and hyaluronic acid in connective tissue and glycogen in muscularis.
- 5) Most of these results are in good agreement with the mucosubstances reported in the pyloric stomach of other vertebrates.
- 6) Some of the functions of pyloric mucosubstances such as buffer against acidic chyme and protection of mucosa have been discussed and suggested.

#### IV) Duodenum

- 1) The duodenum consisted of mucosa, submucosa, muscularis and serosa. The surface epithelium contained columnar epithelial cells and goblet cells. The duodenal or Brunner's glands were found to be absent.
- 2) There is no sexual dimorphism in the duodenum.
- 3) The mucosubstances in the various histological sites of the duodenum resembled in their histochemical reactivities to the identical mucosubstances in other organ-systems.
- 4) The histochemical results revealed the presence of neutral mucosubstances in the columnar epithelial cells and serosa; sulfomucins and sialomucins in the goblet cells; neutral

mucosubstances, sulfomucins and hyaluronic acid in connective tissue and glycogen in the muscularis.

- 5) Most of these results are in good agreement with the mucosubstances reported in the duodenum of other vertebrates.
- 6) Some of the functions of duodenal mucosubstances such as protection of the mucosa and buffer against the gastric acidic chyme have been discussed and suggested.

V) Small intestine

- 1) The small intestine consisted of mucosa, submucosa, muscularis and serosa. The surface epithelium contained columnar epithelial cells and goblet cells. Intestinal glands and crypts were found to be absent.
- 2) There is no sexual dimorphism in the small intestine.
- 3) The mucosubstances in the various histological sites of the small intestine resembled in their histochemical reactivities to the identical mucosubstances in other organ-systems.
- 4) The histochemical results indicated the presence of neutral mucosubstances in the columnar epithelial cells and serosa; sulfomucins and sialomucins in the goblet cells; neutral mucosubstances, sulfomucins and hyaluronic acid in the connective tissue and glycogen in muscularis.
- 5) Most of these mucosubstances are in good agreement with the mucosubstances reported in small intestine of the other vertebrates.
- 6) Some of the functions of intestinal mucosubstances such

as protection of the mucosa against proteolytic enzymes and blocking the attachment of the micro-organisms to the membrane receptors are discussed.

#### VI) Large intestine

- 1) The large intestine consisted of mucosa, submucosa, muscularis and serosa. The surface epithelium contained columnar epithelial cells and goblet cells. The glands were not observed.
- 2) There is no sexual dimorphism in the large intestine.
- 3) The staining reactivities of the mucosubstances in various histological sites of the large intestine were similar to those exhibited by identical mucosubstances in other organ-systems.
- 4) The histochemical results indicated the presence of neutral mucosubstances in columnar epithelial cells and serosa; neutral mucosubstances and sulfomucins in goblet cells; neutral mucosubstances and hyaluronic acid in connective tissue and glycogen in muscularis.
- 5) These results are practically similar to those reported in the large intestine of the other vertebrates.
- 6) Some of the functions such as lubrication and prevention of dehydration have been discussed in relation to the mucosubstances in large intestine.

#### C O N C L U D I N G   R E M A R K S

Thus, the aims and objectives with which the present

investigation was undertaken have been successfully fulfilled. The main aims of the present investigation were to study the histology of the various organs from esophagus to large intestine, sexual dimorphism, if any, in these organs, histochemical characterization of mucosubstances, their distribution in various histological sites of these organs, comparison of the results obtained and existing literature and to project idea about the functional significance of mucosubstances in various organs based on circumstantial evidences. It is hoped that these aims and objectives have satisfactorily been achieved.

While concluding the present M.Phil.dissertation on the alimentary tract mucosubstances in one of the Anurans, the author would like to humbly state that the present work is by no means complete. He is fully aware of his shortcomings. For the purpose of studying the concentration or content of mucosubstance/s in a given histological site in an organ, the author had to entirely depend on the visually estimated intensity of staining. Though the differences in the staining intensities do give indirectly some idea about the mucosubstance content, they do not form reliable criteria while reporting the amount of mucosubstance/s. Hence the terms such as "quantities", "predominance," "trace quantities," "small amount" or "level" of mucosubstances need to be understood keeping the above short comings in mind. As the mucosubstances in tongue and pharynx of this frog have already been investigated these organs have not been included in the present investigation.

This, hence forms an excellent subject matter for further



studies. Further studies should be carried in the following directions:

- 1) The mucosubstances identified in the present investigation should further be studied by employing the bioassay studies to find out the exact quantities of mucosubstances in the given organ of the alimentary tract in mathematical terms.
- 2) The mucosubstances in the various organs investigated should further be isolated by chromatography and further be characterized.
- 3) The mucosubstances in the various organs should further be confirmed by employing autoradiographic studies.
- 4) Some of the mucosubstances such as neutral mucosubstances, sulfomucins etc. should be further identified.
- 5) Whether any atypical mucosubstances present in the alimentary tract mucosubstances should be studied in vertebrates including amphibians.
- 6) Whether sexual dimorphism present in the alimentary tract should further be studied in vertebrates at histological or histochemical level.
- 7) The species diversity of alimentary tract mucosubstances should further be confirmed by studying large number of animals including some closely related species.
- 8) Since the mucosubstances in tongue and pharynx of this frog have been investigated these organs have not been investigated. But these organs should also be included while studying the alimentary tract mucosubstances in

the other animals.

- 9) The mucosubstances in the various organs of the alimentary tract, whether differ according to the diatory habits of the animals should be investigated by selecting animals differing in their diet.
- 10) The functions of the mucosubstances in the various organs of the alimentary tract of animals should be confirmed by experimental studies involving alteration of the food, including pathological conditions etc.

Thus the present investigation shows that there are several avenues open for further researches.

Some studies are going on in these directions in this laboratory on alimentary tract of several vertebrates from fishes to mammals, the results of which will be published in the due course of time. In this laboratory there is no provision for autoradiography, even there is no ultracentrifuge for separation of different sediments and there is no electron microscope for ultrastructural studies. Even with all these shortcomings, the author feels gratified that atleast he has provided some preliminary observations on alimentary tract mucosubstances in one of the Anurans by employing a battery of histochemical techniques. There is unlimited scope for further researches on mucosubstances and their physiological importance in the alimentary tract of vertebrates.

"To make an end is to make a  
beginning  
The end is where we start  
from"

.....T.S.Eliot