

Summary and

concluding remarks

---

S U M M A R Y

AND

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 mainly been studied in the alimentary tract of mammals and comparatively less attention has been given to the submammalian vertebrates. Moreover, for such studies, some workers had<sup>ve</sup> selected either esophagus or stomach and others selected duodenum only or intestine of different animal. There are very few investigations which include the studies on mucosubstances from the esophagus to large intestine of one and the same animal. Recently, Lim and Low (1977) pointed out that "The gastrointestinal tract of avian forms is an area of particular interest since the mucosal surfaces are known to be highly specialized in different parts of tract." This stimulated to undertake the present investigation on the mucosubstances in alimentary tract of pond heron, A. grayii.

In last four to five years investigations on mucosubstances in the alimentary tract have successfully been completed in this laboratory for the frogs, E. systoma (Mutkekar, 1981) and R. cyanophlyctis (Patil, 1983), toad, B. melanostictus (Mangalware, 1981), skink, M. carinata (Mandlik, 1983) and six species of bats (Deshmukh, 1984). As mucosubstances in the tongue of this bird have been studied (Gaikwad, 1981), the present investigation deals with the mucosubstances in the various region of the alimentary tract from esophagus to large intestine of the pond heron, A. grayii. Several well established techniques have been employed in the present investigation.

The following is a brief resume of the observations and

and conclusions drawn in the present studies.

#### A] ESOPHAGUS

1. The esophagus in the pond heron consisted of mucosa, submucosa, muscularis and serosa. The mucosal epithelium is stratified and without goblet cells. The esophageal glands were found in mucosa.
2. The mucosubstances present in various histological sites of pond heron esophagus resembled in their tinctorial affinities to those exhibited by identical mucosubstances in the other organ-systems.
3. The histochemical results obtained in the present investigation are described in the following tabulated form :

Mucosa	Stratified epithelial cells ;	- Glycogen
	Mucous glands	- Neutral mucosubstances, Sulfomucins and Sialomucins.
Submucosa	Connective tissue	- Neutral mucosubstances
Muscularis		- Glycogen
Serosa		- Neutral mucosubstances

4. The histological and histochemical studies revealed the absence of sexual diamorphism in the esophagus of this bird.
5. Some of these mucosubstances are identical to the esophageal mucosubstances in the other vertebrates. This point is discussed in the light of the existing literature.
6. Protection of mucosa and lubricating function have been attributed to the secreted mucins in the esophagus based on the circumstantial evidences.

STOMACH

The avian stomach is a dual structure. The thin walled and glandular anterior region of the stomach is called as proventriculus and posterior highly muscular region is known as gizzard or ventriculus. A small pyloric bulb is present behind gizzard.

B] PROVENTRICULUS

1. The proventriculus in the pond heron consisted of mucosa, submucosa, muscularis and serosa. Mucosa is thrown into many folds and lining epithelium consisted of only goblet cells. Many compound tubuloalveolar glands were present extending in submucosa and opened by collecting ducts at the region of gastric pits. The cells lining the duct can be compared to the mucous neck cells and remaining cells in the gland were analogous to oxyntic cells in other lower vertebrates.
2. The histological staining reactivities of the various histological sites of the proventriculus of the pond heron resembled to those exhibited by the identical mucosubstances in the other organ-systems.
3. The histochemical results obtained in the present investigation are recorded in the following tabulated form :

Mucosa	Surface goblet cells	- Neutral mucosubstances, Sulfomucins and Sialomucins
	Glands	
	Duct cells	- Sulfamucins (predominant) Neutral mucosubstances (poor)
	Secretary cells	- Neutral mucosubstances

Submucosa	Connective tissue - Neutral mucosubstances
Muscularis	- Glycogen
Serosa	- Neutral mucosubstances

4. The histological and histochemical results indicated the absence of sexual dimorphism in the proventriculus of pond heron.
5. Some of these results are in good agreement with existing literature on the gastric mucosubstances in the other vertebrates.
6. Some of the functions such as lubrication, protection of mucosa buffer against gastric acidity and antipeptic activity of mucosubstances have been discussed and suggested in the light of the circumstantial evidences.

#### C] GIZZARD OR VENTRICULUS

1. The gizzard of pond heron consisted of mucosa, submucosa, muscularis and the serosa. Muscularis is highly developed in this region. Mucosa is folded having crypts. The lining epithelium consisted of goblet cells only. Many tubular glands were present. The non-cellular koilin lining is peculiarity of this region.
2. The histochemical reactivities of the muscularis present in the various histological sites of the gizzard resembled to those exhibited by the identical mucosubstances in the other organ systems.
3. The histochemical results obtained in the present investigation are recorded in the following form :

Mucosa	Surface goblet cells	- Sulfamucins (Predominant)
		Sialomucins (poor)

	Glands	- Neutral mucosubstances
	Crypts	- Sulfomucins (predominant) Sialomucins (Poor)
Submucosa	Connective tissue	- Neutral mucosubstances
Muscularis		- Glycogen
Serosa		- Neutral mucosubstances

4. The histological and histochemical results indicated the absence of sexual dimorphism in the gizzard of pond heron.
5. Some of these above mentioned results are in good agreement with existing literature on the pyloric stomach in the other vertebrates.
6. Some functions such as buffer against the gastric acidic chyme and protection of the mucosa have been suggested to gizzard mucosubstances and discussed in the light of the available literature.

### INTESTINE

The proximal part of the elongated intestine next to the pyloric bulb was distinguished as duodenum, the middle part as small intestine or ileum and the distal part as large intestine or rectum. A small rudimentary caecum is present at the junction of small intestine and large intestine.

#### D] DUODENUM

1. The four typical layers such as mucosa, submucosa, muscularis and the serosa were observed in the duodenum of the pond heron. The mucosal epithelium consisted of columnar epithelial cells and few goblet cells. Mucosa forms few villi like projections.

The glands are absent but well developed crypts were observed between the villi.

2. The mucosubstances in the various histological sites of the duodenum of the pond heron exhibited histochemical reactivities identical to those exhibited by identical mucosubstances in the other organ-systems.
3. The histochemical results obtained in the present investigation are described in the following tabulated form :

Mucosa	Columnar epithelium	- Neutral mucosubstances (poor)
	Surface goblet cells	- Sulfomucins (predominant) and neutral mucosubstances (poor)
	Crypt cells	- Sulfomucins (predominant) and neutral mucosubstances (poor)
Submucosa	Connective tissue	- Neutral mucosubstances
Muscularis		- Glycogen
Serosa		- Neutral mucosubstances

4. The present studies on histology and histochemistry of mucosubstances reveals that there is no sexual dimorphism in the duodenum.
5. The aforementioned results are discussed in the light of the existing literature on duodenum mucosubstances of the vertebrates. Some of these results are in good agreement with the available literature.
6. Some of the functions of the duodenal mucosubstances such as the protection of the mucosa and buffer against the gastric



acidic chyme have been discussed and suggested.

#### E] SMALL INTESTINE

1. The four typical layers such as mucosa, submucosa, muscularis and serosa were found in the small intestine of the pond heron. The mucosal epithelium contained columner epithelium and goblet cells. Villi were more in number, more elongated and contained more number of goblet cells than the duodenum. Crypts are well developed in this region.
2. The histochemical reactivities of the mucosubstances present in the various histological sites of the small intestine of the pond heron resembled to those exhibited by similar mucosubstances in the other organ-systems.
3. The present investigation revealed the following histochemical results in the various cellular sites of the small intestine of pond heron.

Mucosa	Columner epithelial cells	- Neutral mucosubstances (poor)
	Surface goblet cells	- Sulfomucins (predominant) neutral mucosubstances (poor)
	Crypt cells	- Sulfomucins (predominant) neutral mucosubstances (poor)
Submucosa	Connective tissue	- Neutral mucosubstances
Muscularis		- Glycogen
Serosa		- Neutral mucosubstances

4. Identical mucosubstances were observed in both the sexes in the

small intestine of the pond heron which indicated the absence of sex dimorphism.

5. Most of the mucosubstances are in good agreement with the existing literature on the mucosubstances reported in the small intestine of other vertebrates.
6. Some of the functions of intestinal mucosubstances such as the protection of the mucosa against the proteolytic enzymes and prevention of the attachment of the microorganisms to the membrane receptors are discussed based on the circumstantial evidences.

#### F] LARGE INTESTINE OR RECTUM

1. The rectum or large intestine of the pond heron consisted of the mucosa, submucosa, muscularis and serosa. The mucosa consisted of few columner epithelial cells but abundant goblet cells. Few short and broad mucosal folds were observed. Crypts are well developed but glands are absent.
2. The staining reactivities of the various mucosubstances present in the different histological sites of the large intestine were identical to those exhibited by the similar mucosubstances in the other organ-systems.
3. The histochemical results obtained in the present investigation are recorded in the following tabulated form :

Mucosa	Columner epithelial cells	- Neutral mucosubstances (poor)
	Goblet cells	- Sulfomucins (predominant) neutral mucosubstances (poor)

	Crypt cells	- Sulfomucins (predominant) neutral mucosubstances (poor)
Submucosa	Connective tissue	- Neutral mucosubstances
Muscularis		- Glycogen
Serosa		- Neutral mucosubstances

4. The similar histological and histochemical results of mucosubstances indicated the absence of sexual dimorphism in pond heron.
5. These results are practically similar to those reported in the large intestine of other vertebrates.
6. Some of the functions of the large intestine mucosubstances such as lubrication and prevention of the dehydration are discussed in the light of the available literature.

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

The main aims of the present investigation were (i) To study the histology of the various region of the alimentary tract of the pond heron, A. grayii from the esophagus to the large intestine, (ii) To report histochemical characterization of mucosubstances in these organs, (iii) To reveal the pattern of distribution of mucosubstances in the various histological sites of these organs, (iv) To observe sexual dimorphism, if any, in these organs, (v) To compare the results obtained in the present investigation and the existing literature on the other vertebrates and (vi) To attribute some physiological roles to the alimentary tract muco-

substances based on some circumstantial evidences.

It is hoped that the aims and objectives of the present investigation have satisfactorily been achieved.

While concluding the present M.Phil. dissertation on the mucosubstances in the alimentary tract of A. grayii, the author would like to humbly state that the present investigation is by no means complete. The author is fully aware of the shortcomings during the tenure of the present investigation. The author had to depend mainly on the histochemical techniques which give the exact location of the mucosubstances in the given histological site but do not provide information on the exact quantity of mucosubstances in mathematical terms as is given by bioassay studies. Though bioassay studies have not used in the present investigation, the approximate histochemical staining intensities by visual estimation such as "poor", "weak", "moderate" and "intense" may indicate roughly the relative amount of mucosubstances in given histological sites. Though the differences in the staining intensity do give indirectly some idea about the mucosubstances content, they do not form suitable criteria of the amount of mucosubstances.

As the mucosubstances in the tongue of this bird have already been studied, it has not been included in the present investigation. In spite of all the shortcomings, the author feels gratified that he had at least presented preliminary information on the mucosubstance in the alimentary tract of one of the birds by employing series of histochemical techniques according to the availability of the stains and chemicals in this laboratory.

The author would like to suggest the following aspects as directions for further studies which he realized while working on the present investigation.

- 1) By employing recent bioassay studies, the mucosubstances of the various organs of the alimentary tract should be quantited in exact mathematical terms.
- 2) The mucosubstances invested in the avian alimentary tract using histochemical studies should further be confirmed by autoradiography.
- 3) The mucosubstances of the alimentary tract should be seperated by-chromatography and the individual mucosubstance should be characterised.
- 4) The histochemically identifiable mucosubstances such as neutral mucosubstances, sulfomucosubstances etc. should be further identified.
- 5) Sexual dimorphosism has been reported in the duodenum of the hamsters. Whether such sexual dimorphism is present in the alimentary tract of other animals should further be studied.
- 6) Some rarely occuring mucosubstances such as sulfated sialomucins have been reported in the colon of some mammals. Whether such atypical and rare mucosubstances are present in other animals should be investigated.
- 7) Whether mucosubstances present in alimentary tract vary according to the dietary habits should be observed.
- 8) Some experimental studies should be carried out to attribute physiological significance of the alimentary tract mucosubstances.

- 9) The histochemical studies involving large number of animals differing in their feeding habits and species should be worked out.

The present investigation, thus, shows that there are several avenues open for further researches. With all the shortcomings, author feels gratified that he has provided at least some preliminary observations on alimentary tract mucosubstances in one of the birds by employing a recent and well-established histochemical techniques. There is unlimited scope for researches on mucosubstances and their physiological importance in the alimentary tract of avian fauna.

The investigator assumes responsibilities for the opinions expressed in the present report and also for omissions and errors, if any, in the body of the dissertation.