STRUCTURE AND SOME ASPECTS OF HISTOCHEMISTRY OF THE STOMACH OF TWO INDIAN BATS

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ABSTRACT

The squamous epithelium of the oesophagus extends deep into the fundic region of the stomach in the carnivorous *Megaderma lyra lyra*. The cardiac glands are absent from this species and, as the food enters the stomach and reaches the intestine, it is first subjected to acidic mucins followed by both acidic and neutral mucins, then only to neutral mucins followed by acidic mucins. The stomach of *Rhinolophus rouxi* has the usual types of glands, namely, cardiac, fundic, transitional and pyloric. The food is subjected to both neutral and acidic mucins in the cardiac, fundic and transitional regions of the stomach and only to neutral mucins in the pyloric region of this species.

INTRODUCTION

ALTHOUGH several investigators have studied the gastric anatomy of bats[1–8], a critical study correlating the diet of a species with the gastric structure is lacking. Moreover, the little information on the gastro-intestinal mucosubstances[2,5,8–11], is of a very preliminary nature. The present study deals with the structure, histology and mucins secreted by the mucosa in two bats with markedly different dietary habits. While *Megaderma lyra lyra* is carnivorous *Rhinolophus rouxi* is insectivorous.

MATERIAL AND METHODS

Adult specimens of *Megaderma lyra lyra* were collected from old houses and cattle sheds at and around Nagpur, and the specimens of *Rhinolophus rouxi* from a railway tunnel near Khandala, Maharashtra State. The stomachs of these specimens were fixed in either calcium acetate formalin or Rossman's fixative. The tissues were dehydrated and sectioned at a thickness of 5 to 7 μ in the usual way for routine histological study. A battery of techniques[12–14] were employed for histochemical examination. The histochemical classification given by Spicer *et al*[12] has been followed in the present study.

OBSERVATIONS

Figures 1 and 2 give the general anatomy of the stomach in the two bats studied here. The different zones of the stomach namely, the cardiac, the fundic, the transitional and the pyloric can be demarcated only by employing histochemical staining procedures. The conical pyloric sphincter projects into the duodenal lumen, and its aperture lies towards the lesser curvature of the stomach. Hence, in sectional views it appears to be made up of two valves, the valve along the greater curvature being bigger than that along the lesser curvature. The rugae generally lie parallel to the long axis of the stomach in both bats, but those in the fundic caecum of *Megaderma lyra lyra* follow a zig-zag course and hence appear in sectional views in the form of irregular protuberances of different sizes and shapes.

The circular layer muscles form the oesophageal and pyloric sphincters. The Brunner's glands occur in the submucosa of the pocket formed by the protruding pyloric sphincter (Figs. 3 and 4).

The epithelium of the gastric mucosa is glandular throughout the stomach of both these bats. At the gastro-oesophageal junction of *Megaderma lyra lyra*, however, the squamous epithelium of the oesophagus extends deep into the lumen of the stomach (Fig. 5) Hence, the cardiac region is not represented in the stomach of *Megaderma lyra lyra*. The gastric glands, which are present in the area surrounding the gastro-oesophageal junction are similar in structure and histochemical properties to the fundic glands. In *Rhinolophus rouxi*, on the other hand, the squamous epithelium of the oesophagus ends abruptly and is followed by the secretory epithelium of the cardiac part of the gastric mucosa (Fig. 6). The cardiac glands of *Rhinolophus rouxi* have deep foveolae and the pepsinogen cells are present in a very small basal segment of the glands. The interstitial mucous cells and surface mucous cells of the cardiac glands contain profuse secretion.

The pepsinogen cells form the basalmost segment of the fundic glands (Fig. 7), the parietal cells and the interstitial mucous cells form the middle segment of the glands and the surface mucous cells occur distally in both these bats. Although the parietal cells are the dominant cell type in the fundic region, the pepsinogen cells are more abundant in the fundic glands than elsewhere in the stomach.

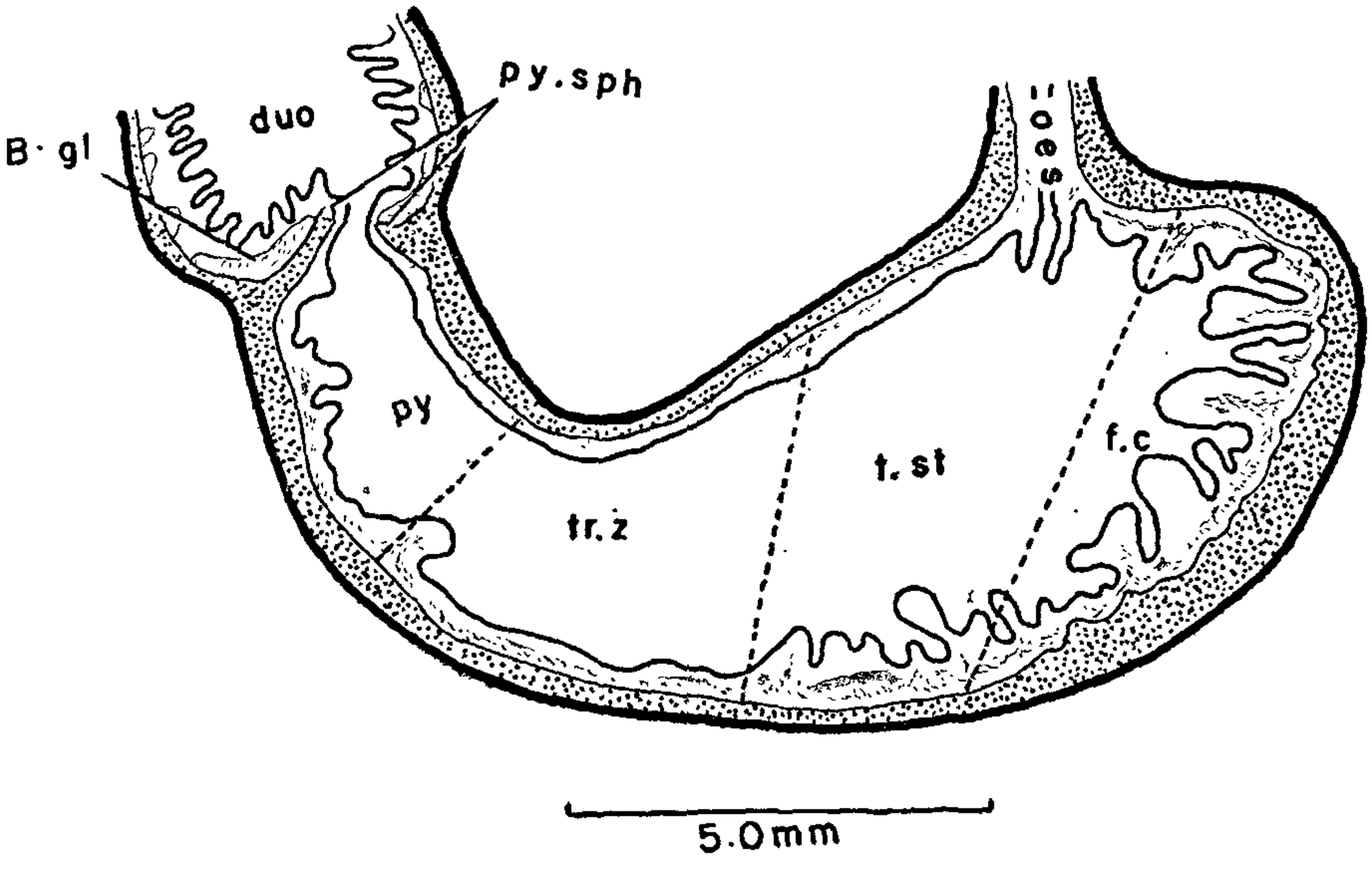


FIG. 1. Semischematic drawing to show the general anatomy of the stomach of *Megaderma lyra lyra.* B.gl.: Brunner's glands; duo: duodenum; f.c.: fundic caecum; oes: oesophagus; py: pylorus; py. sph.: pyloric sphincter; t.st.: tubular stomach; tr. z.: transition zone. The thick black outline represents the serosa as well as the longitudinal layer of muscles of the muscularis externa. The dotted area represents the circular layer of muscles of the muscularis externa.

The gastric glands of the transitional zone are composed of parietal and interstitial mucous cells distally. The interstitial mucous cells predominate in the transition zone of the stomach of both the species of bats (Figs. 8 an 9).

The pyloric mucosa has very deep foeolae and almost the entire pyloric gland is made up of surface mucous cells which contain profuse secretion. A few scattered parietal cells and interstitial mucous cells may occur in the basal segment (Fig. 10).

Cytology of the Gastric Glands and Mucin Histochemistry

The pepsinogen cells are small, polygonal to ellipsoidal in shape and possess basally located nuclei in both these bats. They do not stain selectively with any of the histochemical staining procedures employed here, and hence can be identified only on the basis of their shape and the position of their nuclei in sections stained with haematoxylin and eosin. The parietal cells are large, ellipsoidal and have centrally located nuclei and are negative to all histochemical staining procedures employed here except to PAS with which there is a faint positive reaction which is resistant to prior salivary digestion.

The proximal interstitial mucous cells contain neutral mucins in all the regions of the stomach of *Megaderma lyra lyra.* The distal interstitial mucous cells of the fundic region contain acidic mucins. While some of the distal interstitial mucous cells of the transition zone contain acidic (sialo-) mucins others contain neutral mucins. The interstitial mucous cells of the pyloric region contain only neutral mucins and they are too scanty to be distinguishable into proximal and distal types. The surface mucous cells exhibit different tinctorial affinities in the different regions of the stomach of this species. They contain acidic (sialo-) mucins in the fundic region, both netural and acidic (sialo-) mucins in the transitional zone and only neutral mucins in the pyloric region.

While the proximal interstitial mucous cells of all the regions of the stomach of *Rhinolophus rouxi* (excluding the pyloric region) contain neutral mucins, the distal interstitial mucous cells contain acidic mucins. The interstitial mucous cells of the pyloric region

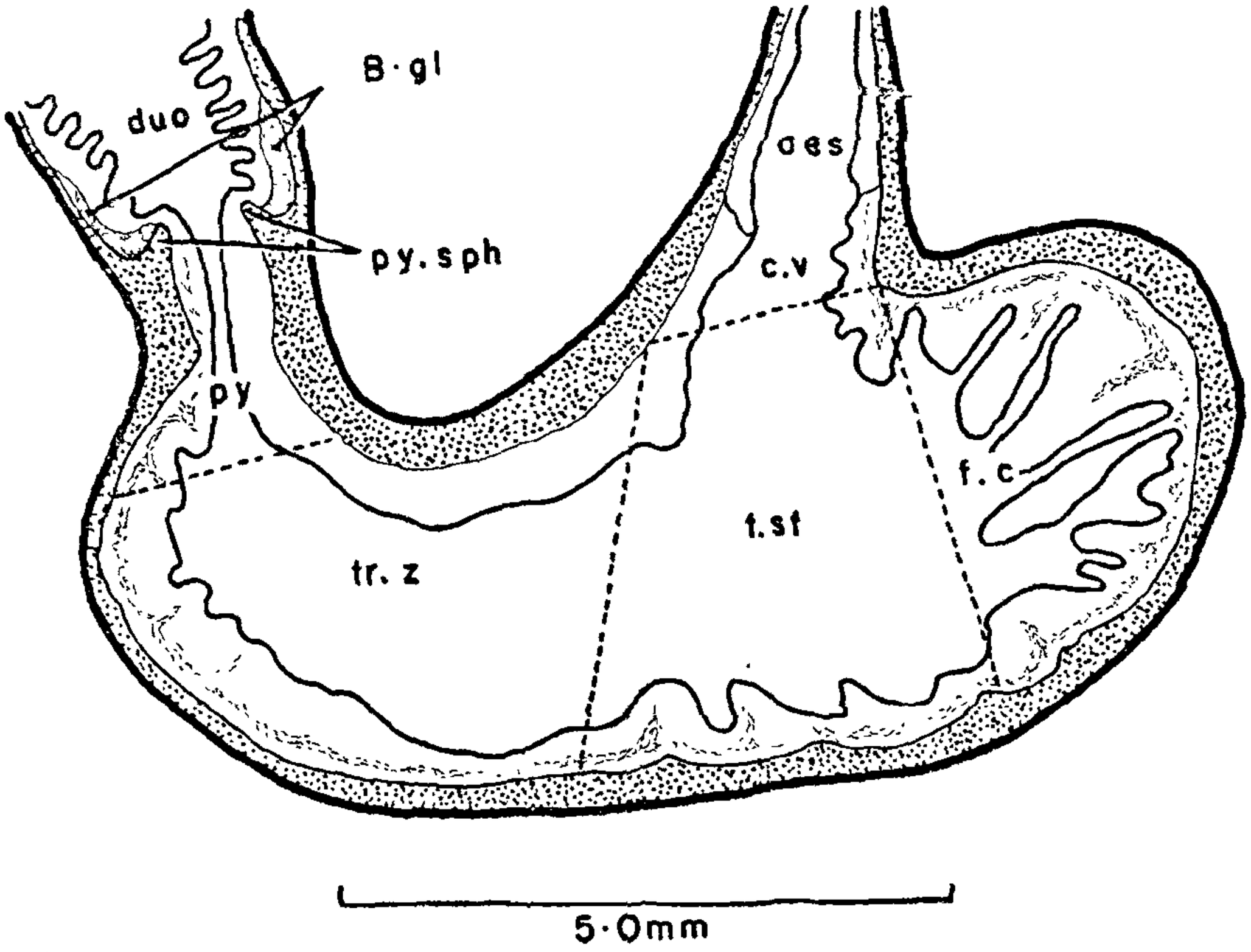
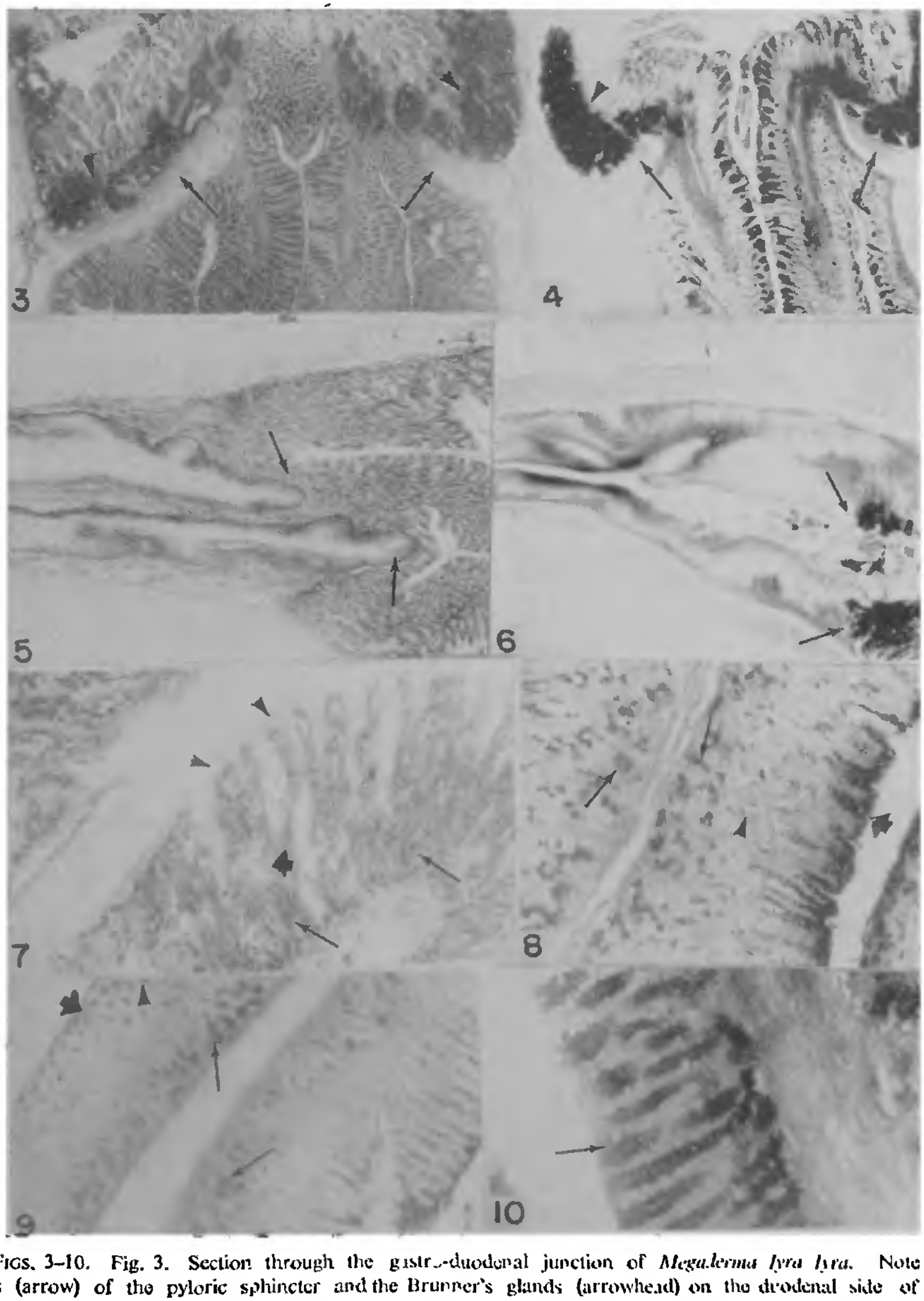


FIG. 2. Semischematic drawing to show the general anatomy of the stomach of *Rhinolophus rouxi* cv. : cardiac vestibule. Other legends as in Fig. 1.

cannot be distinguished into proximal and distal types and contain neutral mucins. The surface mucous cells of all the regions except the pyloric region of the stomach of this species contain both neutral and acidic mucins. The surface mucous cells of the pyloric region have only neutral mucins.

DISCUSSION

In the stomach of *Megaderma lyra lyra* both circular and longitudinal layer of muscles of the muscularis externa are well developed in the region of the fundus which receives the undigested food first. This apparently is an adaptation to suit its diet which consists of small amphibians, lizards, small rodents, etc.[15]., which demands quick and considerable expansion to prevent any tear. The occurrence of a well developed oesophageal sphincter and the projection of the squamous epithelium of the oesophagus deep into the cardiac stomach in the form of a narrow tube are also adaptations for the nature of the food of this bat. On the other hand Forman[5] described the occurrence of asymmetrical flaps lined by squamous epithelium at the gastro-oesophageal junction in *Noctilio leporinus* which is a fish-eating bat. The presence of a closure mechanism either in the form of a sphincter or as a projection of the oesophagus into the cranial end of the cardiac region of the stomach is evidently an adaptation to prevent the quickly consumed large quantity of food from descending into the oesophagus due to gravitation since these animals have an unique upside-down resting posture. However, it is not clear as to why a distinct cardiac region is lacking in *Megaderma lyra lyra*. The stomach of *Rhinolophus rouxi*, which feeds on small insects, is relatively simple



FIGS. 3–10. Fig. 3. Section through the gastro-duodenal junction of *Megaderma lyra lyra*. Note the valves (arrow) of the pyloric sphincter and the Brunner's glands (arrowhead) on the duodenal side of the pyloric sphincter. Haematoxylin—eosin (HE). × 64. Fig. 4. Section through the gastro-duodenal junction of *Rhinolophus rouxi*. Note the valves of the pyloric sphincter (arrow) and the Brunner's glands (arrowhead). (Cl–PAS). × 56. Fig. 5. Section through the gastro-oesophageal junction of *Megaderma lyra lyra*. Note that the squamous epithelium of the oesophagus extends deep into the stomach (arrow). × 64. Fig. 6. Section

through the gastro-oesophageal junction of *Rhinolophus rouxi*. Note the abrupt ending of the squamous epithelium of the oesophagus (arrow)—(CI–PAS). × 56. Fig. 7. Part of a section through the fundic mucosa of *Megaderma lyra lyra*. Note the pepsinogen cells (arrow) at the base, parietal cells (thick short arrow) in the middle segment and surface mucous cells (arrowhead) in the distal segment. (HE). × 220. Fig. 8. Part of the section through the transition zone of *Megaderma lyra lyra*. Note the proximal (arrow) and distal (arrowhead) interstitial mucous cells and surface mucous cells (thick arrow). (AB pH 2·5–PAS). × 220. Fig. 9. Part of the section through the transition zone of *Rhinolophus rouxi*. Note the proximal (arrow) and distal (arrowhead) interstitial mucous cells and surface mucous cells (thick arrow) (CI–PAS). × 88. Fig. 10. Part of the section through the pyloric region of the stomach of *Megaderma lyra lyra*. Note the profuse secretion in the surface mucous cells. (arrow). (AB pH 2·5–PAS). × 220.

in structure. Cardiac glands are prominently present in this species as in most other bats[2,5,9].

With respect to the type of mucins secreted by the distal interstitial mucous cells and surface mucous cells of *Megaderma lyra lyra* it is interesting to note that there exists a gradation from acidic mucins (fundic region) to both neutral and acidic mucins (transitional zone) and finally to only neutral mucins (pyloric region). Further, the Brunner's glands of this species secrete only neutral mucins[16]. It appears, therefore, that, the food during its passage through the stomach is first subjected to acidic mucins, followed by both acidic and neutral mucins, then only to neutral mucins and then again to both neutral (Brunner's glands) and acidic mucins (goblet cells). In *Rhinolophus rouxi* on the other hand, the food is subjected to the action of both neutral and acidic mucins in the stomach as well as in the duodenum.

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