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Light and scanning electron microscopy of duodenum of cattle (*Bos indicus*), Asian elephant (*Elephas maximus*) and Greater one horn Rhinoceros (*Rhinoceros unicornis*)

Anil Deka, NN Barman, Sukanta Das, Bhaskar Choudhury, and P Kakati

Abstract
The present study was conducted on duodenum of Cattle, Elephant and Greater one Horn Rhinoceros for histology and scanning electron microscopy. The mucosal surface of duodenum of cattle, Elephant and Greater one Horn Rhinoceros contained villi and villi were lined by simple columnar epithelium. Lamina propria-submucosa contains intestinal gland along with abundant collagen fibers. Tunica muscularis layer was composed of thick inner circular and outer longitudinal layer. In Elephant, Tunica muscularis as well as Tunica serosa layers were more prominent compared to the Cattle and Rhinoceros. Abundant connective tissue fibers were found in the tunica sub mucosa layer. In scanning electron microscope, the duodenal villi of cattle were broad and wide with a short height along with numerous opening of goblet cells. In Elephant, the shapes of the duodenal villi were leaf shaped and taller than Cattle. The thicknesses of the muscle fibers were more compared to the Cattle and Rhinoceros. In Rhinoceros, the height of the villi was more compared to the Cattle and Elephant. The villi were cone shaped with a broad base and a pointed apex. These villi contain numerous enterocytes along with opening of goblet cells.

Keywords: Light, scanning, electron, microscopy, duodenum, cattle, elephant, rhinoceros

Introduction
Cattle are most common type of large domesticated ungulates. Cattle are commonly raised as livestock for meat for milk, and for hides, which are used to make leather. The Greater one-horned rhinoceros is native to the Indian subcontinent. Greater one horn Rhinoceros is Schedule I animal as per wildlife protection Act, 1972. As per the IUCN status the Greater one horn Rhinoceros is endangered animal. Their population is decreased due to encroachment of habitat by human and livestock, and their pouching for horn. Asian elephant is the largest terrestrial animal in the world. Asian elephant is also Schedule I animal as per wild life protection Act, 1972 whereas as per the IUCN status the Asian Elephant is endangered animal. Their population is also decreased due to encroachment of habitat by human and livestock, and their pouching for ivory and trunk. Literature on the duodenum of cattle (*Bos indicus*), Greater one horn Rhinoceros (*Rhinoceros unicornis*) and Asian Elephant (*Elephas maximus*) is found to be scarce. Therefore, considering the importance of Greater one horn Rhinoceros and Asian Elephant in wildlife the present study was undertaken to elucidate the histomorphological parameters of duodenum.

Materials and Methods
In the present investigation duodenum of Cattle (*Bos indicus*), Greater one horn Rhinoceros (*Rhinoceros unicornis*) and Asian Elephant (*Elephas maximus*) were utilized. I have already taken the permission from the concern authority. The tissue sample of cattle were obtained from slaughter house of cattle and the tissue sample of Greater one horn Rhinoceros (*Rhinoceros unicornis*) and Asian Elephant (*Elephas maximus*) were obtained from Assam forest department. Immediately after death the duodenum were fixed in ten percent neutral buffered formalin and processed for paraffin embedding method. Paraffin sections of five micron thickness were stained with Haematoxylin and Eosin for histomorphological, Van Gieson's for collagen fibre [6]. For scanning electron microscopy, the tissue samples were processed as per the standard protocol of Sophisticated Analytical Instrumentation Facility,

North Eastern Hill University and viewed in Indian Institute of Advance Study of Science and Technology, Pachim Boragaon, Gorchuk. As per the standard method developed by North Eastern Hill University.

Results and Discussion

Duodenum was the first part of small intestine. Histologically, the wall structure of duodenum was consists of Tunica mucosa, Tunica submucosa, Tunica muscularis and Tunica serosa. Thought the basic histological structure was same in all the three species but in cattle, mucosal surface of duodenum contained finger like villi. These finding was corroborated with the findings of [4] in indigenous Gazella (*Gazella subgutturosa*).The shape and size of the villi were different. Most of villi were long and slender and located at irregular intervals. The villi were lined by simple columnar epithelium interspersed with goblet cells. The lamina propria was consists of areolar connective Tissue, where blood vessels and intestinal glands were present. Lamina muscularis mucosa was located deep to the lamina propria.The tunica submucosa composed of a loose connective tissue layer as well as Brunner's gland. The tunica musculosa consisted of thick inner circular and thin outer longitudinal layer of smooth muscle fibers. This finding was in accordance with the finding of Thitaram *et al.*, (2018) in Asian Elephant calves (*Elephas maximus*). The tunica serosa consisted of connective tissue fiber and covered by a single layer of mesothelium. The mucosal surface of duodenum of Rhinoceros also contains Villi. Similar findings were reported by [3] in White Rhinoceros (*Ceratotherium simum*). The height of villi was more compared to the Elephant and Cattle. The shapes of the villi were broad base with pointed apex (leaf like).The villi were lined by simple columnar epithelium. Lamina propria-submucosa contains intestinal gland along with abundant collagen fibers. Tunica muscularis layer was composed of thick inner circular and outer longitudinal layer. A thick muscularis layer was observed in the duodenum of elephant. Similar finding was observed by Aswegen *et al.* (1996) in African elephant. In Elephant, Tunica muscularis as well as Tunica serosa layers were more prominent compared to the Cattle and Rhinoceros. Abundant connective tissue fibers were found in the tunica submucosa layer (Fig.6).

In scanning electron microscope, the duodenal villi of cattle were broad and wide with a short height along with numerous opening of goblet cells. These findings were in agreement with the findings of Gautam *et al.*, (2017) in Caprine intestine. In Elephant, the shapes of the duodenal villi were leaf shaped and taller than Cattle. The thicknesses of the muscle fibers were more compared to the Cattle and Rhinoceros. In Rhinoceros, the height of the villi was more compared to the Cattle and Elephant. The villi were cone shaped with a broad base and a pointed apex. These villi contain numerous enterocytes along with opening of goblet cells.

Summary and Conclusion

In Elephant, Tunica muscularis as well as Tunica serosa layers were more prominent compared to the Cattle and Rhinoceros. In scanning electron microscope, the duodenal villi of cattle were broad and wide with a short height along with numerous opening of goblet cells. In Elephant, the shapes of the duodenal villi were leaf shaped and taller than Cattle. The thicknesses of the muscle fibers were more compared to the Cattle and Rhinoceros. In Rhinoceros, the height of the villi was more compared to the Cattle and Elephant. The villi were cone shaped with a broad base and a pointed apex. These villi contain numerous enterocytes along with opening of goblet cells. These studies will be helpful to the wildlife veterinarian for identification of this organ. These basic data will be helpful for scientists who are working in this area for further research.

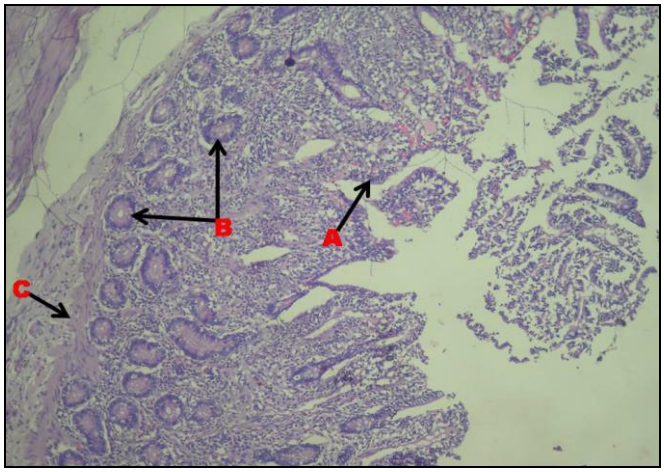

Fig 1: Photomicrograph showing the lining epithelium (A), intestinal gland (B) and lamina muscularis mucosae (C) of duodenum of Cattle, H&E,10X

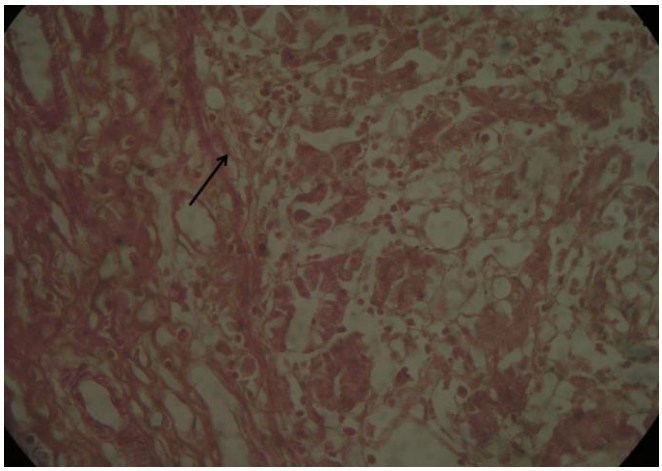

Fig 2: Photomicrograph showing the collagen fibers (black arrow) of duodenum of Cattle, H&E, 40X

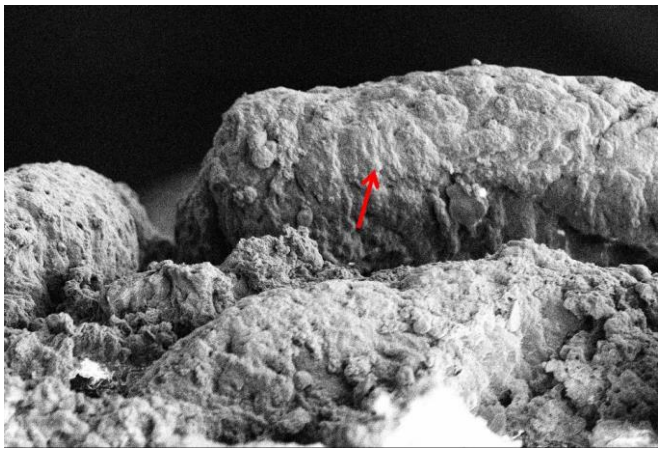

Fig 3: Scanning electron micro photograph showing the villi of duodenum of cattle.

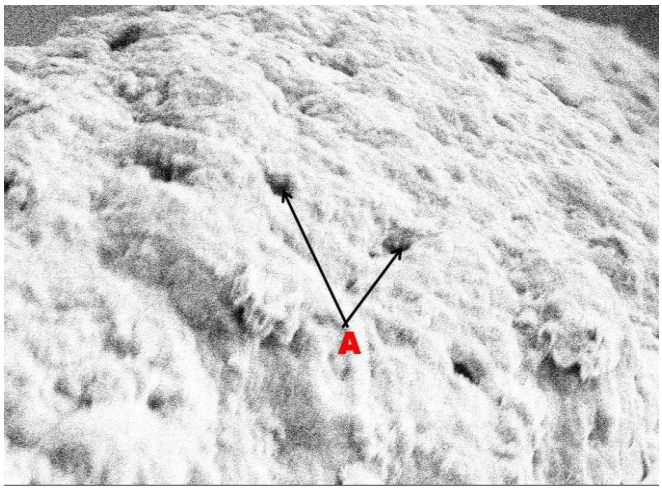

Fig 4: Scanning electron micro photograph showing the goblet cell of duodenum of cattle.

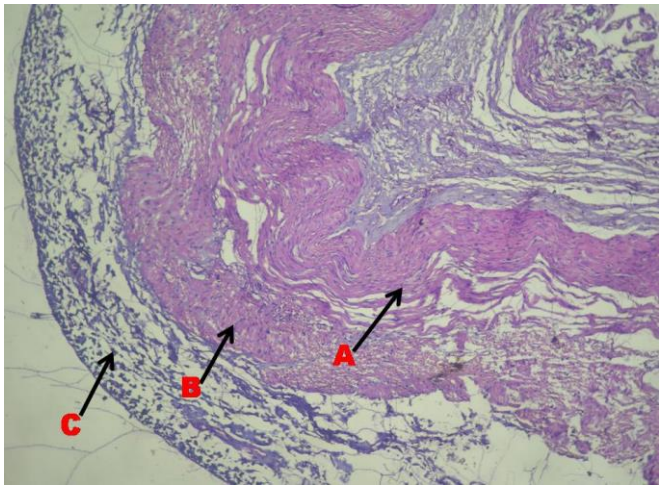

Fig 5: Photomicrograph showing the inner circular (A), and outer longitudinal (B) l of tunica mucosa layer as well as tunica serosa of duodenum of Asian elephant.H&E, 40X

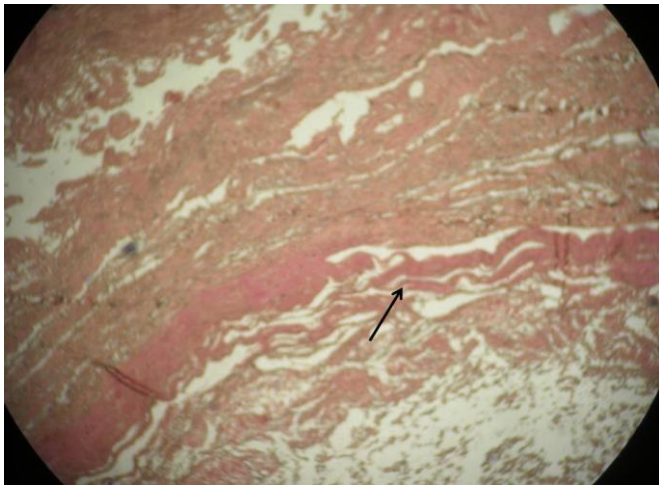

Fig 6: Photomicrograph showing the collagen fiber (black arrow) of duodenum of Asian elephant VAN GIESON'S METHOD, 40X

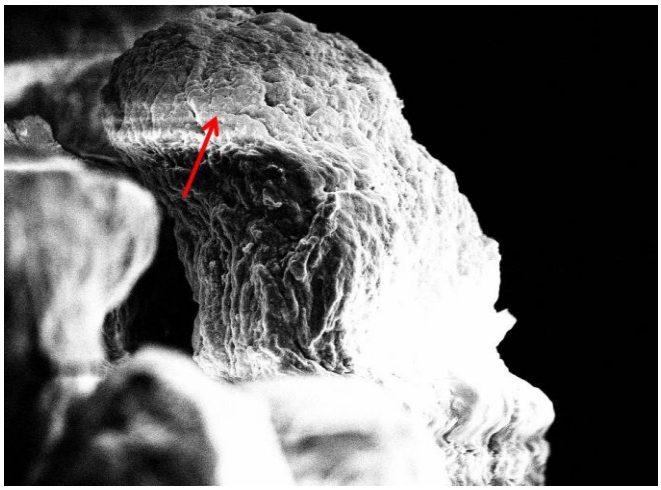

Fig 7: Scanning electron microphotograph showing the villi of duodenum of Asian elephant

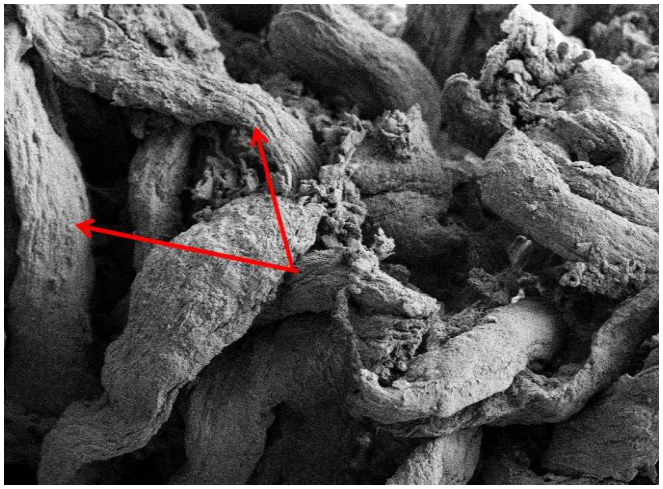

Fig 8: Scanning electron microphotograph showing the muscle fiber of duodenum of Asian elephant

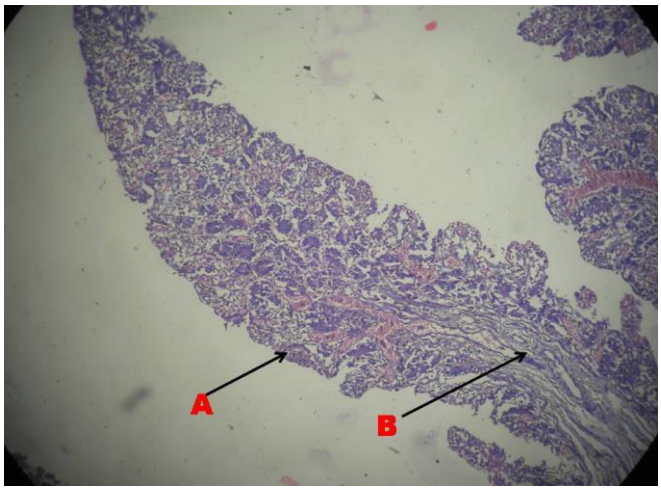

Fig 9: Photomicrograph showing the lamina epithelialis mucosae (A) and lamina propria (B) of duodenum of Greater one horn Rhinoceros

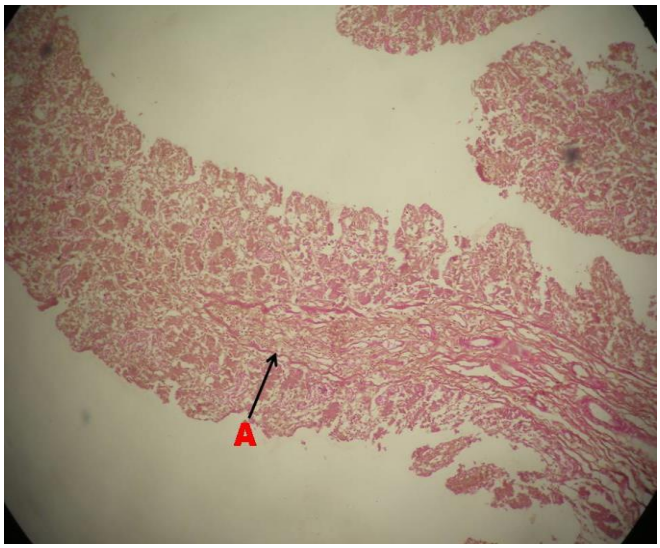

Fig 10: Photomicrograph showing the collagen fiber of duodenum of Greater one horn Rhinoceros.VAN GIESON'S METHOD,40X

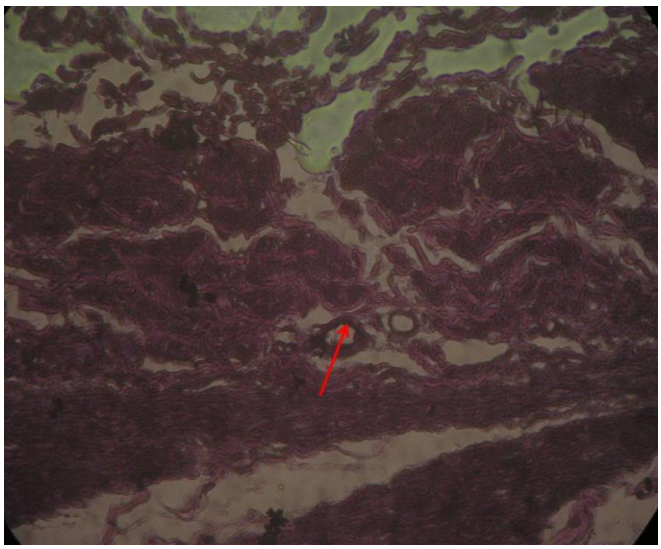

Fig 11: Photomicrograph showing the elastic fiber of duodenum of Greater one horn Rhinoceros HART'S METHOD, 40X

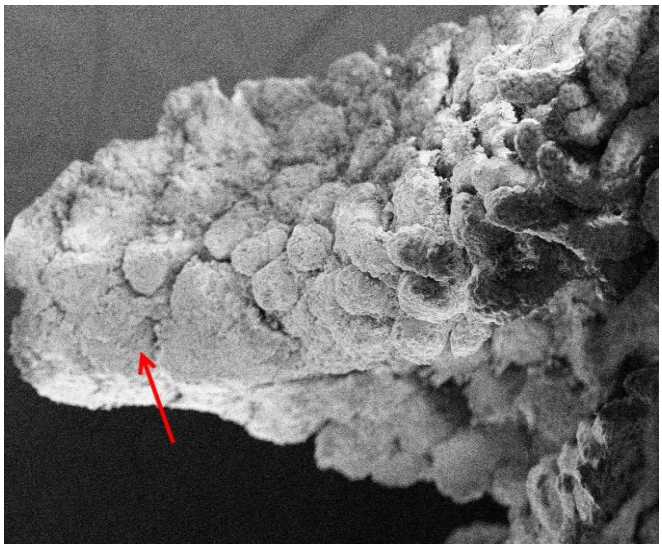

Fig 12: Scanning electron microphotograph showing the cone shaped villi of duodenum of Greater one horn Rhinoceros

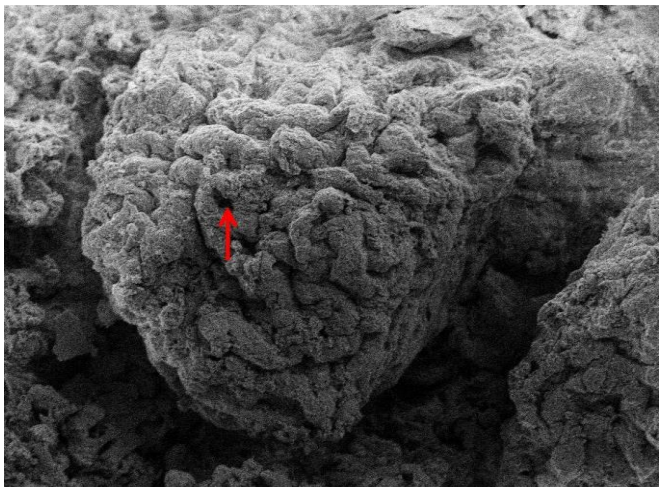

Fig 13: Scanning electron microphotograph showing the opening of goblet cell of duodenum of Greater one horn Rhinoceros

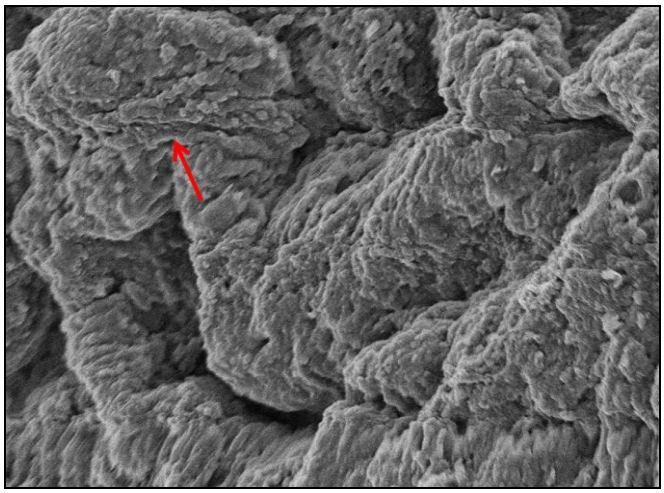

Fig 14: Scanning electron microphotograph showing the enterocytes of duodenum of Greater one horn Rhinoceros

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