TRADITION AND MODERNITY IN VETERINARY MEDICINE, 2018, vol. 3, No 2(5): 50–54

MORPHOFUNCTIONAL INVESTIGATION OF BROWN BEAR (*URSUS ARCTUS*) STOMACH

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ABSTRACT

Histological investigation and functional comment of the brown bear stomach structure wall and its comparison with another carnivorous as dog, fox, wolf, jackal, cat and tiger, respectively which were surveyed previously was the aim of this study.

The stomach of a female brown bear after sudden death was obtained and slides by conventional histological method were examined microscopically and morphometry was done.

In mucosal layer of the brown bear stomach as in other investigated canine species the subglandular layer stratum compactum was not established also, as opposed to feline species in which stomach's mucosa this specific collagenous layer was always presented.

Key words: stomach, histology, carnivorous, bear.

Introduction

Brown bear (*Ursus arctus*) belong to Class *Mammalia*, Order *Carnivora* of the family *Ursidae*, and it is classified as caniforms, or doglike carnivores. It is predominantly distributed in mountain areas that are less urbanized, and so people are afraid of meeting them. And perhaps to prove themselves as a master of nature and because of the valuable hunting trophy, they are fighting unequally despite its physical superiority. The bear has been hunted in the past and according to data of the International Union for Conservation of Nature (IUCN), the total number now in the world is about 200 000. According taxonomy the scientific name of the brown bear – *Ursus arctos*, comes from the Latin language "ursus", meaning bear, and Αρκτος (arctos), from the Greek word for bear.

The bear has been subjected to various genetic and ecological studies on its origin, structure and behaviour (Klinka, D. R. and Reimchen, T. E., 2002; Pàges, M., 2008). In our country there are little scientific reports that are related to clinical cases and the bear has been treated (Manov, V. et al., 2013; Aminkov, B. et al., 2017; Aminkov, B. et al., 2018) and more one popular book on subject (Gunchev R., 1994). There are furthermore small morphological scientific investigation and data focusing on specific comparative morphofunctional explanation of bear organism and most specific is that bear's kidney is superficially furrowed outside (Kovachev, G. et al., 2016).

There is little data on the digestive organs of mammal carnivores but it is considered that they are primarily intended for meat consumption. According manner of eating they must bite and rip their food off and probably because their teeth are brachidont, as herbivores chew side to side that so crushing the feed and their teeth are hypsodont. Unlike humans, their saliva does not contain digestive enzymes. Carnivores have a shorter digestive tract. This is because meat is dense in nutrients and they can extract these nutrients easier. The actual size of a carnivore stomach is significantly large than herbivores. Their stomachs encompass roughly 60 to 70% of their digestive tracts. Within their stomach they have powerful digestive enzymes. They have roughly 10 times

more the excretion of hydrochloric acid in their stomach than humans or herbivores. Their caecum, however is much smaller in comparison of other animals (Marshall Cavendish, 2010).

The bear has a seasonal menu, looking to get food with minimal effort. He carefully collects and devours everything he gets. The intensive feeding is in the autumn when it is abundant in food – plants, fruits, seeds, mushrooms, roots, sweet fern, corn, juicy grass, bulbs, insects, bee honey. Then the species reaches its maximum weight, which will allow it to get the winter in hibernation condition without food. Mainly in the spring after „awakening" the bear feeds on meat – fishes, frogs, small rodents, birds, or sacrifices can become freely grazing domestic animals, diversifying daily portion of about 10-15 kg weight with eggs, snails, worms, insects and their larvae. In artificial bear parks the menu is carefully selected and no meat with bones is included for feeding (Cicnjak, L. et al., 1987; Frackowiak, W., 1997; Hewitt, D. G. and Robbins, C. T., 1996).

Anatomically, the stomach of carnivores resembles a lot of human, both in shape and in a device where the entire mucosal surface is glandular, unlike that of the horse and the pig, in which animals about 1/3 of the surface is aglandular cutaneus mucosa (Kovachev, G. et al., 2016).

In histological literature many authors (Bacha, W. Jr.and Wood, L. M., 1990; Krystev, H. and Vitanov, S., 1993) are described specific lamina subglandularis in carnivorous stomach wall as the presence into the propria mucous layer. Some other histologists present double-layered structure in lamina propria mucosae underneath the bases of the stomach glands (Smollich, A., 1972; Stinson, A. W. and M. Lois Calhoun, 1993). According to them the first layer which is situated closer to the bottoms of the glands and it is designated as stratum granulosum due to the fact that it is rich of connective tissue cells and their nuclei give impression for granulation. The other deeper layer which is positioned just to the lamina muscularis mucosae and has denser collagen structure is designated as stratum compactum. According to other authors (Frappier, B. L., 2006) and by Nomina Histologica (14) only a single collagenous acellular layer stratum compactum exists in carnivorous stomach mucosa, which hypothetically protects the wall of perforations taking in mind the bone composition and the sharp edges in their food.

The study aim was an investigation of the histological structure of the brown bear stomach wall and made comparison with another carnivorous animals as dog, fox, jackal, wolf, cats and tiger, respectively which stomachs were surveyed previously and to comment the obtained results on the morphofunctional reason for this.

Materials and methods

The stomach of a female brown bear obtained after sudden posttraumatic death in the park with dancing bears in Belitsa town was obtained and examined microscopically. The samples taken for histological investigation were fractionally fixed in 10% buffered formalin after the gastrotomy. Histological slides for microscopic investigation were conventionally prepared. The tissue samples were embedded in paraffin wax and sections 7 μm thick were stained with hematoxylin and eosin. An observation and morphometry of prepared samples by using „Olympus" (Olympus Co Ltd., Tokyo, Japan) microscopic computer system was done.

All investigated methods are done in accordance with the Bulgarian low for protection and human attitude with animals and were under observation of institutional ethics committee of FVM.

Results and discussion

As we expected the wall of the bear stomach showed a typical layered structure (Fig. 1.). The fourth main layers, as glandular mucosa followed by tela submucosa, then musculature and after that serosa are histologically presented. In stomach glands the excretory epithelial cells as mucous cells (mucocytes cervicales), chief cells (exocrinocytes principales) and parietal cells (exocrinocytes parietales) are shown. Cervical mucocytes with their cytoplasmic vacuoles are transparent, but chief cells which include pepsinogen are stained basophilic and parietal cells respectively with their chlorides are eosinophilic. The proportion between the last two types of cells is almost equal. An individual smooth muscle cells belonging to the most inner mucosal muscle laminae are observed between glandular tubules. No sign of the layer stratum compactum as belt-like collagen formation is observed in the bear stomach mucosa just under the tubular glandular bottoms and before mucosal muscular lamina. Usually gland bottoms are closely to the muscle cells of lamina muscularis mucosae but in some areas glands are significantly dislocated. The thickness of mucosal layer vary between 300-800 μm and nuclei of fibroblasts and fibrocytes are in observing area between tubules. Furthermore, the specific layer stratum compactum neither in small intestine nor in large intestine mucosal layer of the bear intestinal duct was not established in our additional investigation.

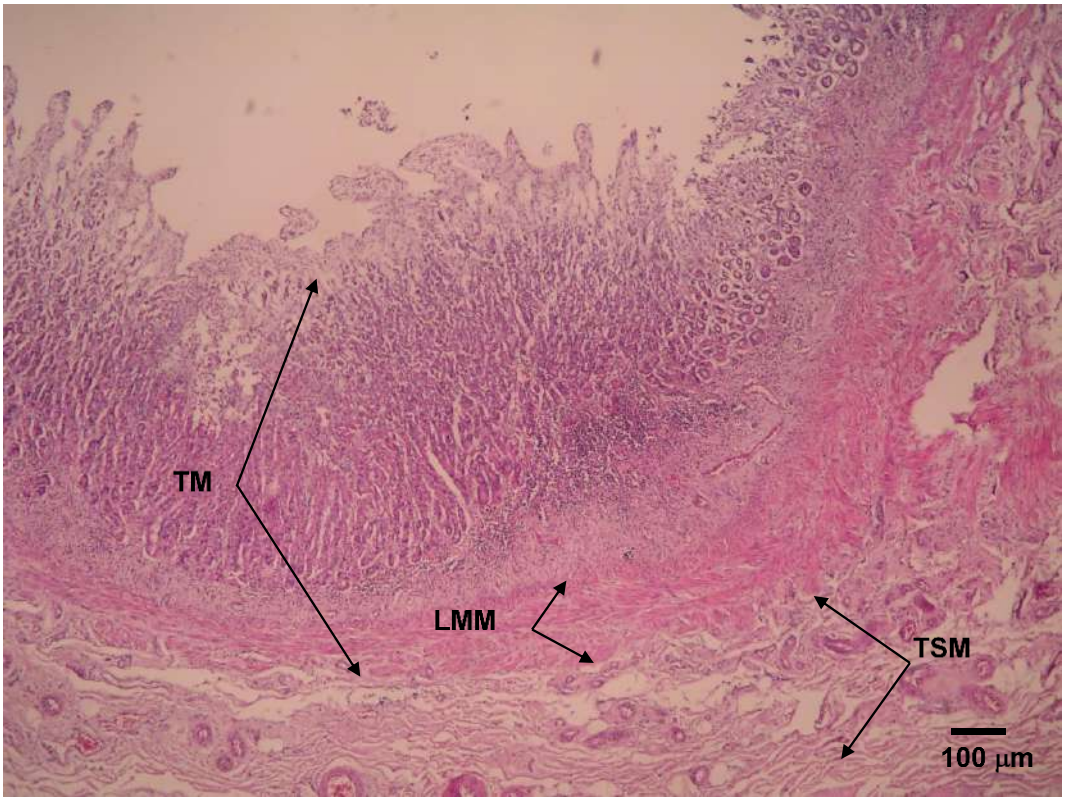

Figure 1: Bear mucosal and submucosal layers. TM – Tunica mucosa; LMM – lamina muscularis mucosae; TSM – Tela submucosa.

Adequately to these facts in another investigated stomachs belonging to animals of Family *Canidae* the mucosal layer stratum compactum also dismisses, as for example in fox, jackal, wolf and dog species (Sapundzhiev, E. et al., 2008, 2017; Zahariev, P. et al, 2010, 2014. This distinctive feature is only comment by Bacha W. J. and Wood L. M., 1990, who reports that the cat stomach has layer stratum compactum, but the later one may be absent in dog's stomach. In comparison to this characteristic, in another investigated stomachs of animals that are belonging to Family *Felidae*, the mucosal layer stratum compactum was presented, as for example in domestic and wild cat and tiger. The final one mucosal lamina muscularis is well-developed as three layer organization and thick smooth musculature bundles interrupted by thin connective tissue streaks forming perimysium were established. The thickness vary between 100–200 μm and the existence of smooth muscle cells between the glandular tubules conforms the data of Frappier, B. L., 2006, who also presents three layered structure of this lamina in another animal's stomachs. In submucosa bear stomach a branched network of myotypical arterial and venous blood vessels was observed and their triple-layered construction was clear demonstrated. The smaller arterioles and venules and respectively capillaries as well as lymphatic vessels were also visible. The muscle layer – tunica muscularis, of the wall is proportionally developed from three-positional situated bundles of smooth muscle cells which are better presented in cardiac and pyloric regions. An autonomic intramural myenteric nervous plexus containing multipolar neurons was found between muscular fascicles. The most outer denser serous layer was morphologically presented and it's composition of dense fibrous layer and superficial mesothelium, consisting of one layer squamous epitheliocytes, was observed.

Conclution

Dismissing of the layer stratum compactum in brown bear stomach is a similar fact as in another canine animal species like dog, fox, wolf and jackal but it differs in cats and tiger where it was demonstrated. This fact supports the hypothesis that the mucosal layer stratum compactum probably is not presented in all animals belonging to Family *Canidae* but it usually permanently exists in animals of Family *Felidae*, nevertheless that these both families belong to the Order *Carnivora* animals. This fact is probably due to the different manner of eating of the representatives belonging to these two families

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