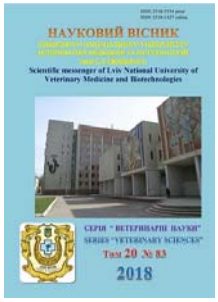

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Morphology of the esophageal mucosa in long-eared owl and eurasian jay

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The morphology of the esophageal mucosa in long-eared owl (Asio otus) and Eurasian jay (Garrulus glandarius) has been studied. Samples with exception of the region of the esophageal tonsil were obtained from 3 adult birds of each species. They were studied by light microscopy using classical methods of morphological research. The tissue samples were fixed in 10% neutral buffered formalin and embedded in paraffin block and finally the section were cut at 5–10 μm thickness using sliding microtome and stained with hematoxylin and eosin, according to Van Gizon and Weigert and impregnated with silver nitrate according to Kelemen. The esophageal mucosa consisted of four layers: epithelium, lamina propria, muscularis mucosae, and submucosa. The epithelium was stratified squamous and better developed in the cranial part of the esophagus. The lamina propria was represented by a loose connective tissue with small amount of elastic fibers. In the long-eared owl tightly located numerous small secretory sections of the esophagus glands organised in 1–3, and in branches of large folds up to 6 layers, were found. Their short excretory ducts opened to the surface of the mucosa. The muscularis mucosae was represented by a smooth muscle tissue with bundles of cells directed longitudinally and in some areas appeared to be absent. The submucosa was well developed, and as well as lamina propria was formed by a loose connective tissue with a large number of elastic fibers. In the submucosa of the Eurasian jay secretory departments of large, not tightly located, esophageal mucous glands were found. The esophageal mucosa of this birds formed well-developed folds, which were composed of all its layers. Their number in the long-eared owl was 20–25 and in the Eurasian jay – 5–9. The shape of folds on the transverse section is not the same: in the long-eared owl it was finger-shaped and leaf-shaped, but in the Eurasian jay it was wedge-shaped. Some large folds in the long-eared owl branched into the secondary mucosal folds. The height of folds in cranial part of the esophagus was larger than in caudal part. In both parts of the esophagus of long-eared owl the height of the large and middle folds was larger than that in the Eurasian jay. The height of small folds in the Eurasian jay was greater than that in the long-eared owl. In both parts of the esophagus of this birds, the fold's width at the base exceeded its width at the top. In the Eurasian jay the width of base and top of large, medium and small folds was larger than that in the long-eared owl. The esophageal mucosa was poor on immune formations. They were represented by single accumulations of diffuse lymphoid tissue, and in the Eurasian jay – even by secondary lymphoid nodules.

Key words: *long-eared owl, Eurasian jay, esophagus, mucosa, esophageal glands, immune formation, lymphoid tissue.*

Морфологія слизової оболонки стравоходу сови вухатої та сойки

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З'ясована морфологія слизової оболонки стравоходу сови вухатої (Asio otus) та сойки Garrulus glandarius). Матеріал для досліджень, крім ділянки розташування стравохідного мигдалика, відібрали від дорослих птахів (n = 3 кожного виду). При виконанні роботи використовували класичні методи мікроскопічних досліджень. Для їх проведення відібраний матеріал піддавали фіксації у 10% водному розчині нейтрального формаліну і заливали за загальноприйнятою методикою у парафін. Гістологічні зрізи виготовляли на санному мікротомі товщиною 5–10 мкм і фарбували гематоксиліном та еозином за Ван Гізон, за Вейгертом та імпрегнували азотнокислим сріблом за Келеменом. Слизова оболонка стравоходу птахів утворена чотирма шарами: епітелієм, власною і м'язовою пластинками та підслизовою основою. Епітелій багатошаровий плоский частково зроговілий і найкраще розвинений у

краніальній частині стравоходу. Власна пластинка представлена пухкою волокнистою сполучною тканиною з невеликою кількістю еластичних волокон. У сови вухатої в ній дуже щільно розташовані численні дрібні секреторні відділи стравохідних залоз, що лежать під епітелієм в 1–3, а в розгалуженнях великих складок і до 6 шарів. Їх короткі вивідні протоки відкриваються на поверхню слизової оболонки. М'язова пластинка слизової оболонки представлена гладкою м'язовою тканиною, пучки клітин якої мають поздовжній напрямок. Місцями вона переривчаста. Підслизова основа слизової оболонки добре виражена, вона, як і власна пластинка, утворена пухкою волокнистою сполучною тканиною з великою кількістю еластичних волокон. У сойки в ній містяться секреторні відділи крупних, нещільно розташованих стравохідних залоз. Слизова оболонка стравоходу птахів утворює чітко виражені складки, в утворенні яких беруть участь всі її шари. Їх кількість у сови вухатої становить 20–25, а у сойки – 5–9. Форма складок на поперечному зрізі неоднакова: у сови вухатої – пальцеподібна і листоподібна, а у сойки – клиноподібна. Окремі великі складки у сови вухатої розгалужуються на вторинні. У птахів висота складок в краніальній частині стравоходу більша, ніж в його каудальній частині. В обох частинах стравоходу у сови вухатої висота великих і середніх складок більша, ніж у сойки, а у сойки, навпаки, висота малих складок більша, ніж у сови вухатої. У птахів ширина основи складок перевищує ширину верхівки в обох частинах стравоходу. У сойки ширина основи і верхівки великих, середніх і малих складок більша, ніж у сови вухатої. Слизова оболонка стравоходу птахів бідна на імунні утворення. Останні представлені поодинокими скупченнями дифузної лімфоїдної тканини, а у сойки – ще й вторинними лімфоїдними вузликами.

Ключові слова: *сова вухата, сойка, стравохід, слизова оболонка, стравохідні залози, імунні утворення, лімфоїдна тканина*

Introduction

It is known, that the esophagus of birds is a tubular organ, which is located between the pharynx and the proventriculus. It has two parts: cranial (cervical) and caudal (chest-abdominal). The mucosa of the esophagus forms longitudinal folds. In their formation take part epithelium, lamina propria, muscularis mucosae and submucosa. Typical feature of mucosa is the presence of well developed esophageal glands, which produce mucus secretion (Krok, 1962; Bobylev, 1969; Pleshakova, 1989). There are data, that in the mucosa of the bird's esophagus immune formations are located as small accumulation of diffuse lymphoid tissue and lymphoid nodules (Kovtun et al., 2003; Dyshlyuk and Orlova, 2017).There, under the influence of antigens, a differentiation of lymphocytes into effector cells takes place, which causes specific immunity (Sapin and Etingen, 1987).

Structural features of the mucosa of the esophagus are well-studied in hens (Dyshlyuk, 2011; 2014; 2016; 2017), but not enough in the wild birds. The purpose of this research was to study the structural features of the esophageal mucosa in long-eared owl and Eurasian jay.

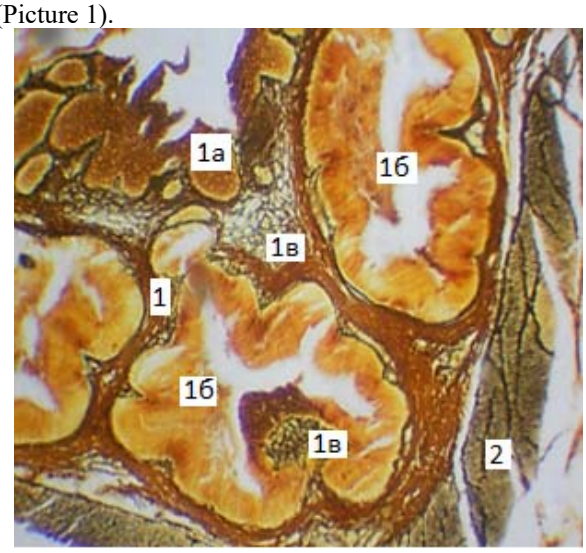
Material and methods

Sample with, exception of the region of esophageal tonsil, were obtained from 3 adult birds of each species. They were studied by light microscopy using classical methods of morphological research. The tissue samples were fixed in 10% neutral buffered formalin and embedded in paraffin blocks and finally the section were cut at 5–10 μm thickness using sliding microtome and stained with hematoxylin and eosin, according to Van Gizon and Weigert, and impregnated with silver nitrate according to Kelemen (Kelemen, 1971; Horalskyi et al., 2005).

Results

The esophageal mucosa of birds consisted of four layers: epithelium, lamina propria, muscularis mucosae, and submucosa. The epithelium was stratified squamous and better developed in the cranial part of the esophagus. The lamina propria was represented by a loose connective tissue with small amount of elastic fibers. In the long-eared owl tightly located numerous small secretory sections of the esophagus glands organised in 1–3, and in branches of large folds up to 6 layers, were found (Picture 1).

Picture 1. Cranial part of the esophagus of the long-eared owl: 1 – folds of the mucosa: 1a – esophageal glands; 1б –secondary folds; 2 – muscularis mucosae. Silver impregnation according to Keleman, x 63



Picture 2. Cranial part of the esophagus of the Eurasian jay: 1 – mucosa: 1a – epithelium; 1б – esophageal glands; 1в – diffuse lymphoid tissue; 2 – muscularis mucosae. Silver impregnation according to Keleman, x 90

Their short excretory ducts opened to the surface of the mucosa. The muscularis mucosae was represented by a smooth muscle tissue with bundles of cells directed longitudinally and in some areas appeared to be absent. The submucosa was well developed and, as well as lamina propria it was formed by a loose connective tissue with a large number of elastic fibers. In the submucosa of the Eurasian jay secretory departments of large, not tighly located, esophageal mucous glands were found (Picture 2).

The esophageal mucosa in this birds consisted of well-developed folds, which were composed of all its layers. Their number in the long-eared owl was 20–25, and in the Eurasian jay – 5–9. The fold's shape on the transverse section was not the same: in long-eared owl it was finger-shaped and leaf-shaped, but in Eurasian jay it was wedge-shaped.

Depending on the height, we divided folds into large, medium and small. Some large folds in long-eared owl branched into the secondary mucosal folds (Picture 1). According to the table 1, the height of folds in cranial part of the esophagus was larger than in caudal part. In both parts of the esophagus in long-eared owl, height of large and middle folds was greater than in Eurasian jay. The height of small folds in Eurasian jay was greater than in long-eared owl.

The width of folds of the esophageal mucosa in studied birds we measured in the area of their basis and top. According to the data from the tables 2 and 3 in both parts of the esophagus, the width at the base exceeded the width at the top. In the Eurasian jay the width of base and top of large, medium and small folds was greater than in the long-eared owl.

Table 1
The height of esophageal mucosa in studied birds, μm

Species of birds	Cranial part			Caudal part		
	large	medium	small	large	medium	small
The long-eared owl	1613.04 ± 26.53	1278.52 ± 31.50	430.75 ± 33.16	1567.22 ± 39.79	1223.53 ± 69.63	417.01 ± 28.18
The Eurasian jay	1521.39 ± 59.69	1232,69 ± 63.01	687.37 ± 33.16	1498,48 ± 54.71	1150.21 ± 48.08	595.49 ± 33.32

Table 2
The width of folds of the esophageal mucosa in the area of their basis, μm

Species of birds	Cranial part			Caudal part		
	large	medium	small	large	medium	small
The long-eared owl	407.84 ± 18.24	339.11 ± 13.26	238.29 + 19.89	430.75 ± 26.52	343.66 ± 16.56	247.45 ± 26.53
The Eurasian jay	1168.54 ± 82.89	829.43 ± 18.24	591,14 ± 23.21	1205.19 ± 76.26	852.34 ± 33.16	636.97 ± 36.47

Рис. 3. Caudal part of the esophagus of the Eurasian jay: 1 – mucosa: 1а – epithelium; 1б – esophageal glands; 1в – secondary lymphoid nodule; 2 – muscularis mucosae. Hematoxylin and eosin, x 90.

The esophageal mucosa was poor on immune formations. They were represented by single accumulations of diffuse lymphoid tissue, and in Eurasian jay – even by secondary lymphoid nodules (Picture 3).

Diffuse lymphoid tissue consisted of homogeneous accumulations without visible rarefactions and condensations in the center. Reticular fibers connected among themselves and created net in which cells of lymphoid series are located. Accumulations of diffuse lymphoid tissue were situated under the epithelium or invaginated into it. As the result, it became spongy. This accumulations were also located inside and near the esophageal glands. Among glandular epithelial cells, there were cells of lymphoid series.

In the Eurasian jay isolated secondary lymphoid nodules were located between esophageal glands, which were morphological markers of immunocompetence (Picture 3). They had mainly round shape and light center. This center was surrounded by tightly located lymphocytes, which created mantle zone. Reticular fibers in central area of secondary lymphoid nodules were isolated and rarefied, but on the periphery – circle-oriented and took part in the formation of capsule.

Table 3
The width of folds of the esophageal mucosa in the area of their top, μm

Species of birds	Cranial part			Caudal part		
	large	medium	small	large	medium	small
The long-eared owl	307.03 ± 23.21	261.20 ± 31.50	164.97 ± 19.89	311.61 ± 19.89	270.36 ± 28.18	187.88 ± 23.21
The Eurasian jay	701.12 ± 76.26	604.89 ± 19.89	316.17 ± 23.19	737.78 ± 49.74	627.80 ± 29.84	339.08 ± 26.51

Conclusions

1. The esophageal mucosa in studied birds consisted of well-developed folds, which were different in all its layers. Their number in the long-eared owl was 20–25, and in the Eurasian jay – 5–9. The shape of folds on the transverse section was not the same: in the long-eared owl it was finger-shaped and leaf-shaped, but in the Eurasian jay it was wedge-shaped. Some large folds in the long-eared owl branched into secondary mucosal folds.

2. The height of folds in cranial part of the esophagus was greater than in caudal. But the indices of width, on the contrary, – were larger in caudal part, than in cranial.

3. Esophageal glands in the long-eared owl were small, tightly located in the mucosal lamina propria, but in the Eurasian jay – they were large, not tightly located and were located in the submucosa.

4. The esophageal mucosa was poor on immune formations. They were represented by single accumulations of diffuse lymphoid tissue, and in the Eurasian jay – even by secondary lymphoid nodules.

Prospects for further research. Further researches could be directed on studying the morphology of esophagus in other species of wild birds.

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