



# Pathoanatomic Changes in Helminthic Diseases of Karakul Sheep

Vakhidova Adolat Mamatkulovna<sup>1</sup>, Khudoyarova Gavhar Nurmatovna<sup>1</sup>,  
Khudzhanova Muattar Absalamovna<sup>2</sup>, Alimova Ozoda Bekturodovna<sup>2</sup>

<sup>1</sup>Department of Microbiology, Virology and Immunology of Samarkand State Medical University, Samarkand, Uzbekistan

<sup>2</sup>Department of Normal Physiology, Samarkand State Medical University, Samarkand, Uzbekistan

## Email address:

adola.ru@mail.ru (V. A. Mamatkulovna), m.xudjanava1981@mail.ru (K. G. Nurmatovna)

\*Corresponding author

## To cite this article:

Vakhidova Adolat Mamatkulovna, Khudoyarova Gavhar Nurmatovna, Khudzhanova Muattar Absalamovna, Alimova Ozoda Bekturodovna. Pathoanatomic Changes in Helminthic Diseases of Karakul Sheep. *Cell Biology*. Vol. 10, No. 1, 2022, pp. 25-30.

doi: 10.11648/j.cb.20221001.13

**Received:** April 9, 2022; **Accepted:** April 23, 2022; **Published:** May 19, 2022

---

**Abstract:** Many helminthiasis of sheep, in particular gastrointestinal, they cause significant economic damage to sheep breeding. An analysis of the literature and the results of many years of research by Uzbek scientists shows that with pasture keeping of sheep, almost all animals in the flock are infected with different types of helminths, mainly strongyloids. It should be noted that helminthic diseases, as a pathological condition of the body, does not stop with the elimination of the pathogen. Restoration of impaired body functions occurs over a more or less long time and this is due to the intensity of invasion, as well as the type of pathogen and immunoreactivity of Karakul sheep. And our research allows us to find out pathological changes in the body during pasture and experimental infection of an animal. The purpose of the work. Subject to a thorough pathoanatomic examination of experimental and pasture animals. Materials and methods of research. For experiments on the study of experimental marshallagiosis and nematodiosis of sheep, 13 agelmentose Karakul sheep and 14 fallen animals were taken. Results. Among the pathological changes that are important for pathoanatomic diagnostics, as well as for clarifying pathogenesis issues, changes in the rennet and small intestine of the invaded animals play a special role. The dynamics of pathological changes in the rennet and small intestine (hyperemia, hemorrhages, erosion, development of parasitic nodules, ulceration) during the growth and development of marshallagias indicate the mechanism of their pathogenic action at different stages of their development and the response of the immunobiological reaction of the animal organism. The survival rate of marshallagia in sheep has been established in the range from 5.46% to 29.56%, and nematodes - from 1.18% to 9.58%. Analysis of the results of pathoanatomic studies has shown that with experimental marshallagiosis and nematodiosis, lambs develop deep pathological processes. Conclusions. The degree of pathological changes that occur in the body when strongylate is parasitized primarily depends on its individual sensitivity and resistance. Weakly resistant animals react strongly to the parasitization of even a small number of helminths. The number of helminths and the age of the animal also play an important role in the development of the pathological process.

**Keywords:** Habertiosis, Strongyloidosis, Marshallagiosis, Pathology, Karakul Sheep

---

## 1. Introduction

One of the important stages of studying the pathogenesis of helminthiasis is research to clarify the pathoanatomic picture in the animal's body. These studies allow us to find out the mechanism of the development of the immunobiological reaction of the animal's body to the

pathogenic effect of helminths. Therefore, studying the pathoanatomic picture in the body of lambs with experimental marshallagiosis, nematodiosis and habertiosis, we aimed to find out the development of the pathological process, physiological and immunobiological reactions. The purpose of the work. Subject to a thorough pathoanatomical examination of experimental and pasture animals that have

fallen from helminthic diseases.

## 2. Materials and Methods of Research

For experiments on the study of experimental marshallagiosis and nematodiosis of sheep, 13 agelmentose Karakul lambs of 6 months of age were taken, of which 5 – (№7, 8, 9, 10 17 kg each) infection was carried out by invasive larvae of marshallagia of 5000 copies. to everyone, and 5 – (№ 5, 6, 7, 11 19 kg each) by invasive nematode larvae, the remaining 4 lambs – (№1, 2, 3, 4 18 kg each) were not infected and served as control. To study experimental habertiriosis of sheep, 14 agelminthic lambs of the Karakul breed of 3-4 months of age were selected, of which 5 – № 4, 5, 6, 7, 8 the average weight was 15.4 kg, were experimentally infected with invasive habertia larvae in an amount of 2000 copies. each lamb, 5 heads - No. 1, 2, 3, 9, 10 average weight - 15.7 kg, were not infected and served as a control.

All lambs used in our experiments were obtained and raised in conditions that exclude their natural infection with helminths, and were healthy from other infectious non-contagious diseases.

The distribution of lambs into experimental and control groups was carried out according to the principle of analogues, taking into account the sex, breed, age, live weight and fatness of the animals.

The animals of the experimental and control groups were kept in similar conditions, they were fed at 9, 14 and 18 o'clock. The diet of lambs for each age group consisted of concentrated (compound feed), coarse (hay) and juicy (green alfalfa) feeds according to zootechnical standards.

Lambs received 1-2 ml of fortified medical fish oil daily from vitamin and mineral substances. And from a special feeder – chalk and table salt according to need. Places where animals were kept were regularly cleaned. Invasive larvae of these strongylates obtained from donors served as the material for infection. The eggs obtained, the cultivation of invasive larvae of marshallagia, nematodes and habertii was carried out according to a generally accepted method.

After 2-3-fold determination of clinical, hematological and biochemical parameters of the organism, lambs were infected by infusion through a rubber probe directly into the scar of a pure culture of mobile, viable invasive larvae of strongylates.

During the entire period, in the morning and in the evening, observations were made of the general condition of the infected and control animals (temperature, pulse, respiration, rumination, the state of visible mucous membranes and conjunctiva), as well as appetite and the act of defecation, the dynamics of live weight were taken into account.

All experimental animals on the 70-75 th day of observation (after infection) were slaughtered, followed by a complete helminthological autopsy according to the method of academician K. I. Scriabin and processing of the results obtained, as well as a detailed description of the pathoanatomical changes of each organ separately [3-6, 15].

## 3. The Results of the Study

Our review of the literature data for this chapter shows that the clinical manifestation of strongylatoses is characterized by diversity and atypicality, the degree of which depends on the intensity of invasion, age, conditions of maintenance and feeding, as well as on the individual reactivity of the animal's organism [13, 14].

With marshallagiosis, clinical signs in sheep appeared from the very first days of invasion. On the 2-3 day after infection, the lambs showed signs of mild depression. They were sluggish, lay down more, got up only after taking food [10, 11].

Appetite decreased slightly compared to the control. The body temperature of most lambs was in the upper normal range (39.5-40.0°C), the pulse increased slightly (80-90 beats per minute). Breathing increased to 35.

In some lambs, in the first days after infection, there was a disorder of the digestive system, characterized by the release of liquid, fetid feces.

In the period from 5 to 10 days of invasion, these clinical signs somewhat weakened, only a sluggish state and sedentary lambs were noted, compared with the control ones. On the 10-15 day, the majority of infected lambs increased depression, lack of appetite, paleness of visible mucous membranes appeared.

Clinical signs were most pronounced from the 20th to the 30th day of the invasion and were reduced to the following: lethargy, lack of appetite, an increase in body temperature to 41.5-42°C, increased pulse rate to 80-120 beats. min. And his arrhythmia, increased heart tones, rapid shallow and often wheezing breathing (45-50 per minute) in some lambs, the release of semi-liquid fetid feces with an admixture of blood was observed. Nervous phenomena were observed only shortly before the death of diseased animals (pal 1 out of 5) [7-9].

All the infected lambs were characterized by a lag in growth and development from the control ones, which manifested itself to varying degrees.

With marshallagiosis of fallen and killed lambs, signs of exhaustion (underdevelopment of musculature and subcutaneous tissue), anemia of visible mucous membranes were noted.

In one lamb No. 7, who fell on the 30th day of the invasion, the conjunctiva was hyperemic, stagnant phenomena were noted. Unlike the control ones, the coat was dull without a natural shine, the hair was weakly held in the hair follicles, dryness of the skin was noted.

At the autopsy of the corpses, 50-100 ml of liquid from straw-yellow to reddish-yellow light was found in the chest cavity.

The heart of most lambs was of normal volume, gray-red color, elastic consistency. Lambs No. 7, 8, and 12 had spot and even spilled spotty hemorrhages on the endocardium, as well as on the cardiac lacunae.

In all lambs of the control group, as well as in some of the infected, macroscopic changes in the heart were not detected.

The lungs of most of the infected lambs did not undergo any special changes. However, some lambs showed signs of developing catarrhal pneumonia: a slight increase in lung volume, on a pale pink background of normal lung tissue, foci of dark red or gray-white color appeared, which differed in dense consistency. The cavity of the trachea and bronchi contained a foamy bloody fluid (impurities of mucus and blood). The mediastinal lymph node was enlarged 2-3 times in size, compacted, in a dark red light section.

The liver was slightly enlarged in most lambs. Some had pronounced dystrophic changes in the liver parenchyma - jaundice, smoothing of the pattern, flabbiness.

The kidneys of all lambs were of normal volume, grayish-red or reddish-brown in color. The capsule was easily removed, and the vessels under it were usually injected. The section clearly shows the boundary between the cortical and cerebral layers.

The spleen of lambs did not change in volume, with the exception of one lamb No. 8, in which there was a slight decrease in the volume of the spleen, jagged edges and dry parenchyma. The color of the spleen: grayish-red and dark cherry on the outside, from light red to dark red on the incision.

Gastrointestinal tract. The scar, mesh and book contained fodder masses, their mucous membrane was gray in color. There were no significant changes in the pre-stomachs. The abomasum in all lambs underwent varying degrees of changes.

According to A. O. Oripov [12], the development of pathological changes in rennet can be diverse and correspond to the processes of migration, growth and development of parasites, as well as the intensity of invasion.

For example, in our experienced lambs, characteristic nodular lesions with ulceration were found in the abomasum.

Thinning, hyperemia, hemorrhage and erosion of the rennet wall were observed. The contents of the abomasum with a reddish tinge (a mixture of mucus with blood) and helminthoscopy were found in it from 273 to 1478 copies of marshallagia. The number of parasites in different sheep was different in No. 7, a total of 1,478 specimens were found, including 64 preimaginal, 428 immature and 981 mature; No. 8 – 352 specimens, including 138 preimaginal, 153 immature and 427 mature, but no preimaginal; No. 9 - 784 specimens are all mature, including 32 preimaginal and 752 mature specimens.

The small intestine, less pronounced to pathological changes than rennet. There were: hyperemia and catarrhal inflammation of the intestinal mucosa, the presence of single nodules of lesion and in most cases only on the duodenum.

Mesenteric lymph nodes in lambs (especially in the fallen) were inflamed: increased in size by 1.5-2 times, grayish-pink in color, dense consistency.

No special changes were found in the other organs. Analysis of the results of macroscopic studies of organs and tissues of lambs with experimental marshallagiosis indicate severe pathology caused by parasitization of marshallagias in their body. The degree of development of the pathological

process, apparently, depends not only on the intensity of invasion, but also on the individual reactive characteristics of individual animals.

Analysis of the results of pathoanatomic studies has shown that with experimental marshallagiosis and nematodyroidism, lambs develop deep pathological processes.

The degree of these pathological changes depends on the intensity and individual characteristics of the organism of individual animals. Among the pathological changes that are important for pathoanatomic diagnostics, as well as for clarifying pathogenesis issues, changes in the rennet and small intestine of the invaded animals play a special role. The dynamics of pathological changes in the rennet and small intestine (hyperemia, hemorrhages, erosion, development of parasitic nodules, ulceration) during the growth and development of marshallagias indicate the mechanism of their pathogenic action at different stages of their development and the response of the immunobiological reaction of the animal organism.

The survival rate of marshallagia in sheep has been established in the range from 5.46% to 29.56%, and nematodes - from 1.18% to 9.58%.

With habertiosis, for three days after infection, lambs, in addition to a depressed state and a decrease in appetite, showed no symptoms, but then from day 4 to 8 they began to refuse food, were sluggish and depressed, their body temperature reached 40.8°C, pulse up to 104 beats min., breathing up to 36, and rumination increased to 4-9 movements (within two minutes). The faeces of individual lambs became liquefied or semi-formed with an admixture of mucus [1, 2].

Clinical signs were especially pronounced in the period from the 8th to the 18th day of the disease, which were expressed in a rise in body temperature to 41.0°C, increased pulse rate, weak filling, shallow breathing and increased rumination to 9-14 movements (within 2 minutes).

At this time, the feces were liquefied, with a fetid smell with an admixture of mucus and blood. The lambs took a characteristic pose: the hind legs were in front. Under the stomach, they arched their backs, moaned and swayed pendularly during defecation, but there was no discharge. The hairline was tousled and easily pulled out.

The superficial lymph nodes were greatly enlarged. And the visible mucous membranes were anemic. There was a swelling of the underbelly and abdomen, on 30-35 days of invasion two lambs fell, who lay for a long time before death, could not get up on their own, and if they lifted them, they either did, staggering two or three steps fell. Or they could not stand on their feet at all, as their limbs convulsively contracted, periodic, frequent swimming movements of the limbs were observed, the discharge of foamy-mucus-like fluid from the mouth. The autopsy results are shown below.

During the period of completion of the preimaginal development of helminths (in 25-30 days), severe thirst was noted, the body temperature dropped to 42.0°C. Increased pulse rate up to 120 beats.min., shallow breathing, but frequent (up to 54) with wheezing.

Clinical signs of the disease in the imaginal period of habertia development were less pronounced, and individual lambs periodically had a depressed state, lack of mobility and decreased appetite. However, during this period of development of the disease, lag in growth and development and more pronounced signs of vitamin deficiency and mineral deficiency were characteristic, compared with marshallagiosis.

These data show that the parasites of the preimaginal stage during their migration are much more active and most strongly manifest their pathogenic properties. The manifestation of nervous phenomena during this period, the loss and weakening of some reflexes, as well as disorders of the cardiovascular, respiratory and digestive systems indicate that the pathogenic effect of parasites affects the entire body, and not its separate organ or separate system.

With nematodyrosis, all experienced lambs had low fatness (exhaustion). Pathoanatomic changes were manifested in pronounced anemia of the mucous membrane of the oral, nasal cavities and conjunctiva, in atrophy of the musculature of the body, the absence of reserves of fat depots.

The liver is enlarged in size, flabby, easily torn, gray, singly scattered nodules the size of a millet grain or slightly larger are visible, gray, shiny or dull on the incision.

Lobular congestive hyperemia and small foci of hemorrhages were observed in the lungs in almost all cases.

The heart is dilated, the muscles are flabby with a spot hemorrhage under the epicardium.

The kidneys were pale with a grayish tinge, the border between the cortical and cerebral layers was smoothed. In some cases, the cerebral layer of the kidneys was characterized by increased swelling, with the presence of swelling of the mucous membrane in the renal pelvis.

Special changes were observed in the localities of the parasites. The mucous membrane of both the abomasum and the small intestine was pale colored. Solitary follicles and Peyer's plaques were swollen, they clearly protruded above the surface of the mucous membrane. Single point hemorrhages or small foci of hyperemia were scattered over the entire surface of the mucous membrane of the small intestine, inflammation of the small intestine was observed. The contents of the stomach, as well as the thin and thick intestine are liquid.

During helminthological examination in the small intestine, the number of nematodes reached from 59 to 479 copies.

For example, a total of 59 copies were found in sheep No. 9. nematodes - all mature; at No. 6 -1148 copies, including immature - 24 and mature -1124 copies; at No. 7 - 149 copies, including immature -36 and mature -113 copies; at No. 8 - 479 copies, including preimaginal - 31, immature - 23 and mature - 425 copies; at No. 9 - 428 copies, including preimaginal - 43, immature - 64 and mature 331 copies.

In the large intestine, the mucosa is hyperemic in places, covered with multiple hemorrhages.

In habertiosis, groups of lambs that fell and were slaughtered in accordance with the work plan, unlike control animals, were characterized by varying degrees of exhaustion,

anemia, atrophic and degenerative changes in all organs.

The visible mucous membranes are pale pink with a cyanotic tinge. The coat is disheveled, the back of the trunk is stained with feces. Subcutaneous tissue does not contain fat, gelatinous infiltrates instead, and up to 1.2-1.5 liters of serous exudate were found in 2 lambs who fell on the 30th and 35th days of invasion in the thoracic and abdominal cavities. Lymph nodes are slightly enlarged, dense. A liver with refined edges and weak degeneration. The heart muscles are flabby with spot hemorrhages under the epicardium. The capsule of the spleen is wrinkled.

The adrenal glands are enlarged, of a dense consistency. The kidneys are brown in color, dark areas appear in places, the border between the cortical and cerebral layers is smoothed. The scar, the grid and the book are unchanged. Contain a liquid mass. There is an insignificant amount of fluid in the small part of the blind and colon. The colon is more often dense, there is a gelatinous infiltrate around them. The mucous membranes are swollen, inflamed, and in some the surface of the mucosa is covered with erosions of various sizes and a large amount of mucus with an admixture of blood. Limited hyperemic areas with hemorrhage protrude over the entire surface of the rectum.

Helminthoscopy of the contents and scraping from the mucous membrane of the colon and partially caecum revealed the presence of infected sheep from 189 to 274 copies. habertius. Their intensity in individual lambs was not the same. For example, in No. 7, a total of 189 copies were found, including preimaginal - 29, immature-109 and mature -61 copies; in No. 8 - 214 copies, including preimaginal -54, immature-21 and mature -139 copies.

Control lambs for all groups were of average fatness, clinical and pathoanatomic deviations from the norm were not found.

## 4. Discussion of the Results Obtained

Characteristic clinical changes in experimental marshallagiosis and nematodirosis were observed mainly during the period of preimaginal development of parasites.

This is due to the fact that invasive larvae of marshallagia, once in the body, migrate to the submucosal abomasum, while violating the integrity of its mucous membrane and secretory activity. As a result, the digestion of feed worsens.

Poorly digested food in the small intestine causes an inflammatory reaction, and toxins and waste products of parasites through the neuro-humoral system affect the entire body.

Clinical signs of experimental marshallagiosis and nematodyrosis in lambs appeared from the very first days of invasion. But the bright symptoms of acute marshallagiosis and nematodyrosis appeared in the period from the 10th to the 20th day of invasion, that is, during the histotrophic phase of parasite development. Characteristic were lethargy of animals, lack of appetite, hanging body temperature up to 41.5-42°C, increased pulse rate up to 80-120 beats per minute, increased heart tones, arrhythmia of the heartbeat,

rapid (up to 45-50 per minute), shallow and often wheezing breathing. Disorders of the digestive organs were observed, expressed in some lambs in the release of semi-liquid fetid feces with an admixture of blood. Nervous phenomena were observed only shortly before the death of sick animals.

During the imaginal period of parasite development, clinical signs in most lambs were weakly expressed or imperceptible. However, during this period of development of the disease, signs of vitamin deficiency and mineral deficiency were characteristic.

All the infected lambs were characterized by a lag in growth and development, which manifested in different lambs and to varying degrees.

Analysis of the results of pathoanatomic studies has shown that with experimental marshallagiosis and nematodiosis, lambs develop deep pathological processes.

The degree of these pathological changes depends on the intensity and individual characteristics of the organism of individual animals. Among the pathological changes that are important for pathoanatomic diagnostics, as well as for clarifying pathogenesis issues, changes in the rennet and small intestine of the invaded animals play a special role. The dynamics of pathological changes in the rennet and small intestine (hyperemia, hemorrhages, erosion, development of parasitic nodules, ulceration) during the growth and development of marshallagias indicate the mechanism of their pathogenic action at different stages of their development and the response of the immunobiological reaction of the animal organism.

The survival rate of marshallagia in sheep has been established in the range from 5.46% to 29.56%, and nematodes and habertii - from 1.18% to 9.58%.

## 5. Conclusions

Thus, it can be judged that the preimaginal stages of strongylate (marshallagium, nematodyrosa and habertii) during their migration are much more active and most strongly manifest their pathogenic properties. The manifestation of nervous phenomena during this period – impaired coordination of movements, convulsions, loss and weakening of some reflexes, as well as violations of the functions of the cardiovascular, respiratory and digestive systems indicate that the pathogenic effect of these helminthiasis affects the entire body, and not its separate organ or a separate system of the body. The rapid development of rather deep, pathological phenomena in the preimaginal period of experimental marshallagiosis and habertiosis also indicates the allergic nature of the course of the disease, as the antigenic effect of these helminths. The degree of pathological changes that occur in the body when strongylate is parasitized primarily depends on its individual sensitivity and resistance. Weakly resistant animals react strongly to the parasitization of even a small number of helminths. The number of helminths and the age of the animal also play an important role in the development of the pathological process.

## References

- [1] Ataev A. M., Karsakov N. T. (2013). Formation of helminthocenoses of lambs' intestines in the context of the altitude zone of Dagestan. Theory and practice of combating parasitic diseases. 2013. No. 14. pp. 38-40.
- [2] Bittirov A. M., Kabardiev S. Sh., Gazimagomedov M. G., Magomedov O. A. (2014). Seasonal susceptibility of lambs of North Caucasian, Karachay and Stavropol breeds of different ages to habertiosis in the foothill zone of the North Caucasus. The successes of modern natural science. 2014. No. 12-5. pp. 535-536.
- [3] Vakhidova A. M., Mukhitdinov Sh. M., Balayan E. V., Mamurova G. N. (2016). New preparations from plant raw materials for the treatment of helminthiasis of animals. XXIV International scientific and practical Internet conference "Trends and prospects for the development of science and education in the context of globalization", Pereyaslav-Khmelnitsky, Ukraine. September 29-30, 2016 Issue -17 p-8.
- [4] Vakhidova A. M., Khudoyarova G. N., Abdurakhimova A., Kamariddin-zadeh M. (2017). Comparison of the local tissue reaction of the structure of the host capsule, around infected and bacteriologically sterile viable echinococcal bladders. Professional formation of the personality of the XXI century in the system of continuing education: theory, practice and prospects. Tashkent 2017 c- 107.
- [5] Vakhidova A. M., Boltayev K. S., Khudoyarova G. N. (2020) Echinococcosis of the lungs complicated by pecilomycosis. RS Global Warsaw, Poland 2020.102 p.
- [6] Vakhidova A. M., Khudoyarova G. N., Muratova Z. T., E. U. Husanov (2021). The significance of lipid peroxidation in liver tissue of animals affected by ecchinosis Turkish Journal of Physiotherapy and Rehabilitation; 2021 32 (2) ISSN 2651-4451 | e-ISSN 2651-446X. p. 4299-4303.
- [7] Gayrabekov R. H., Gayrabekova T. I., Gayrabekova R. H., Molochaeva L. G. (2018). Habertiosis of small cattle and the possibility of predicting outbreaks of habertiosis invasion in the Chechen Republic. Reflection. 2018. No. 2. pp. 41-44.
- [8] Lazarev G. M. (2010). Optimal, environmentally safe technology for protecting animals from parasites in the arid zone of Southern Russia. Methodological recommendations. Elista. 2010. 40 p.
- [9] Lazarev G. M., Kazansky G. I., Polousova O. I. (2012). Marshallagiosis of sheep in the Kalmyk steppe. Theory and practice of combating parasitic diseases. 2012. No. 13. pp. 223-224.
- [10] Maksidova Z. F., Zhekamukhova M. Z., Golubev A. A., Sarbasheva M. M., Shikhalieva M. A., Bittirov A. M. (2013). Marshallagiosis of goats in the North Caucasus region (regional epizootology). Topical issues of veterinary biology. 2013. No. 1 (17). pp. 42-44.
- [11] Murzaliev I. D. (2019). The course of mixed infections in lambs. Bulletin of the Altai State Agrarian University. 2019. No. 7 (177). pp. 143-147.
- [12] Oripov A. O. (1968) Marshallagiosis of sheep in Uzbekistan (epizootology, morphology and biology of the pathogen, pathogenesis, clinic, diagnosis of the disease). //Abstract of the cand. diss. Samarkand, 1968.

- [13] Razikov Sh. Sh., Khudoydodov B. I., Karimov G. N. (2017). Measures to combat strongylatosis of sheep and goats in central Tajikistan. Theory and practice of combating parasitic diseases. 2017. No. 18. pp. 374-380.
- [14] Sokolova V. M., Novak M. D. (2013) Mixed invasions of sheep in farms of the Ryazan region and optimal schemes of therapeutic and preventive measures. Theory and practice of combating parasitic diseases. 2013. No. 14. pp. 366-370.
- [15] Yunusov H. B., Vakhidova A. M., Khudoyarova G. N. (2021). Epidemiology and immune status in echinococcosis of the lungs complicated by pecilomycosis. "Veterinary Medicine", No. 9. 2021. pp. 15-23.