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A clinical cases of tuberculosis in pheasants (*Phasianus colchicus*) with pathomorphological and molecular verification

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Tuberculosis remains one of the leading infectious diseases worldwide, persistently imposing a significant impact on the health of humans and animals. Tuberculosis is a prominent cause of increasing morbidity and mortality even despite achievements in human and veterinary medicine and continuous introduction of novel medical technologies for the control of infectious processes into practice. For this reason, this disease must be considered a multivector problem. However, the consequences of avian tuberculosis for public health have been studied poorly. The relevance of such research is highlighted by the fact that most poultry farmers lack awareness of the spread of avian tuberculosis and its implications, the sources of this infection, its routes of transmission, and zoonotic potential. Therefore, the World Tuberculosis Day is observed annualy to raise awareness of this deadly ailment. The article presents clinical cases of tuberculosis in pheasants (*Phasianus colchicus*) from two private farms in Ukraine, focusing on diagnostic peculiarities and zoonotic importance of the disease. Mycobacterioses continue to be a relevant problem for both domestic and wild birds, playing an important role in the epizootiology of tuberculosis. The paper provides insights into the stages of diagnosing, presented as a complex study with identification of the pathogen using molecular-genetic diagnostics. We provide a detailed pathomorphological description of the changes, taking into account macro- and microscopic peculiarities of the course of tuberculosis in pheasants. The objectives of the study were analysis, elucidation, and systematization of the pathomorphologic peculiarities of tuberculosis in pheasants using a complex of classical and modern methods of diagnostics. For these purposes, we examined 12 corpses of pheasants aged 1.0–1.5 years from private farms in Ukraine. A complex approach was employed, combining pathoanatomical, histological, bacteriological, and molecular-genetic methods. Histological preparations were stained with hematoxylin and eosin, and also using the Ziehl–Neelsen method, and the identification of the pathogen was performed using Real-Time PCR. Macroscopically, we determined a notable cachexia and generalized granulomatous inflammations of the lungs, liver, spleen, and intestine. Histologically, we found typical tuberculosis granulomas with central necrosis, epithelioid cells, and giant Langerhans giant cells. Ziehl–Neelsen stain confirmed the presence of acid-fast mycobacteria. The PCR method established the presence of Mycobacterium avium in the tissues of the internal organs. The yielded results indicate a generalized course of tuberculosis with systemic spread of the pathogen. The study highlights the high diagnostic value of a complex approach involving morphological and molecular-genetic methods, and also underscores the epizootiological and zoonotic significance of avian tuberculosis.

Keywords: tuberculosis; *Mycobacterium avium*; histological study; pathomorphology; bacteriological studies; granulomatous inflammation; molecular-genetic diagnostics.

Introduction

Zoonoses are currently considered some of the most dangerous threats to public health worldwide (Sabuz et al., 2025). Zoonosis can be defined as any disease or infection that is naturally transmitted from vertebrates or invertebrates to humans, or vice versa. Such diseases include rabies, brucellosis, tuberculosis, anthrax, foot-and-mouth disease, and other. Around 75% of recently emerged infectious diseases that affect humans are of animal origin, whereas about 60% of all human pathogens are zoonotic. Among the abovementioned diseases, in Ukraine, tuberculosis has been especially impactful. As a matter of fact, in 1995, the country has declared a TB epidemic, which is still ongoing. However, the possible circulation of TB mycobacteria among representatives of wild fauna in Ukraine has not been studied. This can dramatically complicate complete eradication of this zoonosis in our country, because the data from literature sources suggest the existence of natural hotbeds of the infection in other countries (Korniienko et al., 2023; Polupan et al., 2024; Ukhovskyi et al., 2025).

Mycobacterioses remain a relevant and persistent problem in domestic and pet birds, causing substantial economic losses and constituting a potential risk to human health. Especially important in epizootiology of avian tuberculosis are free-living species that act as natural reservoirs for the causative agent and are a source of infection for poultry (Thorel et al., 2001; Tortoli et al., 2004; Abd El-Ghany, 2022). Via their contact with domestic animals in the conditions of free-range or aviary maintenance, the disease spreads (Dhama et al., 2011; Witte, et al., 2021). Among such species, a significant role is played by feathered game, in particular pheasants (*Phasianus colchicus*), which are widely bred for hunting and agriculture (Hall et al., 2021). Due to their ecological peculiarities, high mobility, and the ability to interact with different groups of animals, pheasants can be a significant link in the circulation of mycobacteria in natural and anthropogenic biocenoses (Ledwoń et al., 2019).

In recent years, bird hunting in Ukraine has been gaining prominence, especially pheasant hunting. Raising pheasants is a laborious but profitable industry, and pheasant meat is popular in restaurants. In Ukraine, raising pheasants is quite promising and is gaining momentum (Novytskyi, 2017; Lyakhovich et al., 2019). Pheasants are common game birds and very susceptible to mycobacterial infections (Lyakhovich et al., 2018). Tuberculosis is a disease in the List B of the World Organization for Animal Health, caused by *M. avium* or *M. genavense*, mostly affecting poultry, domestic birds, or pet birds. Avian tuberculosis caused by Mycobacterium avium is a slowly progressing chronic condition, which is usually diagnosed in birds over one year of age and is characterized by a gradual loss of weight, reduced laying capacity, formation of granulomas in different organs, and ultimately death. Avian tuberculosis was for the first time described in chickens by Crisp y 1868. For pheasants, it was described in 1872. In contrast to animal and human tuberculosis, damages to the lungs occur seldom (Shivaprasad & Palmieri, 2012; Palmieri et al., 2013; Moravkova et al., 2013). As reported, pheasants experience specific pathoanatomical changes, such as infiltration of the intestinal wall with lymphoid elements, indicating a high sensitivity to mycobacteria (Hsieh et al., 2009; Goodarzi et al., 2021). It should be noted that captive pheasants exhibit greater susceptibility to tuberculosis due to the lack of solar insolation and vitamin D deficiency (Bekele et al., 2018; Babazadeh et al., 2022).

As of now, there is no evidence of direct transmission of atypical bacilli among humans, but it cannot be ruled out that ill animals can be a source of infection for humans in the environment (Schmidt et al., 2008). That is why recently, the issue of preventing the spread of avian tuberculosis has been garnering attention. Exotic birds are kept in cages of zoos for many years and can be a discrete source of infection not only for other animals but also for humans. Transmission of tuberculosis to human, although rare, has nonetheless been recorded earlier. The pathogen M. avium can be dangerous to humans, especially those with weakened immune system (Dhama et al., 2011; Kaczmarkowska et al., 2022; Liulin et al., 2023). In humans, all representatives of the complex of *M. avium* and *M. genavense* are able to cause a progressing disease that cannot be treated. Furthermore, besides patients with weakened immunity, including people living with HIV, a risk group for a potential infection is seniors, and therefore is it considered practical to keep infected birds away from the abovementioned, especially vulnerable groups of people (Bodmer et al., 2000; Une & Mori, 2007; Debelu et al., 2021). When studying tuberculosis, we must keep in mind that it is a transboundary disease that can spread extremely fast regardless of national or international borders. Infectious diseases with transboundary potential are able to disseminate rapidly across large areas of different countries, easily overcoming borders, imposing social and economic impacts on society and health of animals and humans. As with tuberculosis on the global scale, it is a serious public health concern, with around nine million people suffering from it worldwide (Kornienko et al., 2024; Syed, et al., 2024). As reported by the WHO, in 2024, tuberculosis was behind 1.23 M human deaths around the globe. According to their estimates, in 2024, tuberculosis was registered in 10.7 M people: 5.8 M men, 3.7 M women, and 1.2 M children. A considerable negative factor of deterioration of the epidemiological situation, not only with tuberculosis, has been the full-scale Russian military aggression against Ukraine, which started on February 24, 2022, and has entailed a large-scale humanitarian crisis and deterioration of heathcare. According to the statistics, in the past year, around 20,000 cases of tuberculosis on average were recorded in Ukraine, including 640 among children, as reported by the Deputy Minister of Healthcare of Ukraine, Chief State Sanitary Doctor of Ukraine Ihor Kuzin during a breefing in a Mediacenter of Ukraine, as reported by Ukrinform (Dzhus & Golovach, 2022; Davydenko et al., 2023; Wilczek et al., 2023).

Despite numerous studies on the epizootiology and laboratory diagnostics of mycobacterioses of birds, the issue of morphological description of tuberculosis in pheasants remains insufficiently studied. At the same time, diagnostics of avian tuberculosis is hindered by its chronic course, nonspecific clinical signs, and limitations of certain methods of clinical diagnostics. Thus, a complex approach is required to establish a final diagnosis (Tell et al., 2001; Dhama et al., 2011).

For the diagnostics of avian TB, pathomorphological studies are of utmost importance. They allow evaluating the pattern and the distribution of granulomatous inflammations, the extent of involvement of the internal organs, and peculiarities of the course of the pathological process. A combination of morphological and modern laboratory methods provides more accurate verification of the disease.

Studying pathomorphological changes in tuberculosis is essential for expanding the understanding of the disease pathogenesis, perfecting diagnostic criteria, and enhancing the effectiveness of differential diagnostics of granulomatous inflammations in birds. Despite available studies, morphological peculiarities of tuberculosis in pheasants require further elucidation and systematization.

The objectives of the study were to describe the pathomorphologic changes in pheasants with tuberculosis and confirm the etiology of the disease using modern laboratory methods of diagnostics.

Materials and methods

To verify the diagnosis, we performed pathohistological examination of corpses of 12 pheasants aged 1.0–1.5 years from two private farms of Poltava District of Poltava Oblast and Bila Tserkva District of Kyiv Oblast, Ukraine. Complete necropsy and pathoanatomical studies of the pheasants were carried out in the postmortem examination room of the National University of Life and Environmental Sciences of Ukraine following the generally accepted methods, sampling the internal organs to detect pathomorphological changes. We gathered fragments of the lungs, spleen, liver, small intestine, and other organs, fixing them in 10% aqueous solution of neutral formalin. After fixation, the samples were washed, dehydrated in ascending alcohols, and embedded in paraffin according to the generally accepted methods (Horalskyi et al., 2025). From the paraffin blocks, we made 4 µm-thick histological sections on a semiautomatic rotary microtome HM 340E (Microm, Germany, 2016). The paraffin sections were stained with hematoxylin and eosin, and also using the Ziehl–Neelsen stain to detect acid-fast mycobacteria and their localizations in the tissues (Horalskyi et al., 2024). The general histological structure and microstructural changes, detected on the histopreparations, were evaluated using a light microscope Axioskop 40 (Carl Zeiss, Germany, 2018). The histopreparations were photographed using a Canon PC 1049 Power Shot G5 camera, 5.0 megapixels (Canon Inc., Japan, 2014) through an Adaptor tube Bayonet – 52 mm Easy Fit for Canon G3 (Canon Inc., Japan, 2014).

Bacteriological inoculation from the internal organs of pheasants (heart, liver, spleen) onto liquid medium, tryptic soy broth (Biolife, Italy, 2024), was carried out according to the generally accepted methods (Sainsus et al., 2008). Ziehl–Neelsen staining of the samples was conducted using a commercial Acid Fast Bacteria acc. Ziehl–Neelsen staining test (Diapath S.p.A, Italy, 2024). Gram staining was performed using a commercial kit of dyes (Química Clínica Aplicada, Spain, 2024).

The acid- fast forms of microorganisms were identified using the Ziehl–Neelsen method. A positive result indicated the presence of acid-tolerant bacteria, specifically mycobacteria, stained red in the histological sections of the internal organs.

The study using the Real-Time PCR method was focused on Mycobacterium avium, the causative agent of avian tuberculosis. For the study, we selected fragments of the heart, lungs, spleen, liver, kidneys, trachea, and jejunum. Isolation of nucleic acids was carried out using an Auto-Pure 32A station (Allsheng, China, 2014) using a reagent kit Lightgene VET-MT-48 (Lightgene Ltd., Ukraine, 2024) for detection of the *Mycobacterium tuberculosis* complex (*Mycobacterium avium*, *M. tuberculosis*, *M. bovis*, *M. africanum*, and *M. microti*) in biological material using the PCR method with hybridization-fluorescent detection of amplification products in real time. The reaction was performed on a system for detecting PCR products in real time regime on a CFX-96 Real-Time System device (BioRad, USA, 2015).

Results

During the pathoanatomical necropsy, we found morphologic changes in the internal organs that are typical for tuberculosis. In the case of the local form of the disease, we recorded grayish-white or yellowish-gray nodules (tubercles), localized in many organs (Fig. 1). In the cases of the generalized form, the pathologic process affected several organs interconnected by vascular and lymphatic vessels. The tuberculous nodules were simultaneously observed in the lungs, liver, spleen, intestine, and on the mesentery, indicating the spread of the infectious process in the body.

Fig. 1. Appearance of the organs of a pheasant with tuberculosis: generalized TB inflammations of the internal organs (multiple granulomatous nodules in the parenchymatous organs)

In the thoracoabdominal cavity, the serous membranes were thickened, matte and bulging at some places, with insignificant fibrinous exudates. The surface of the membranes was uneven, with a slightly dim tone in some regions. The changes corresponded to chronic peritonitis, pointing to a long-lasting chronic inflammatory process.

While examining the organs of the respiratory system, we observed the following. The mucous membrane of the trachea was pale-pink, without hyperemia, erosions, ulcers, or nodular formations, and the wall was not thickened. No noticeable pathological changes were seen. The lung parenchyma presented with numerous granulomatous nodules of rounded shape, measuring up to 5 mm in diameter, of grayish-white color, of dense consistency, distinctly separated from the surrounding tissue. On the section, the nodules were homogeneous, with no signs of softening (Fig. 2). The presence of the aforementioned formations indicates the development of specific productive granulomatous inflammation of tuberculous type. The inflammations were focal.

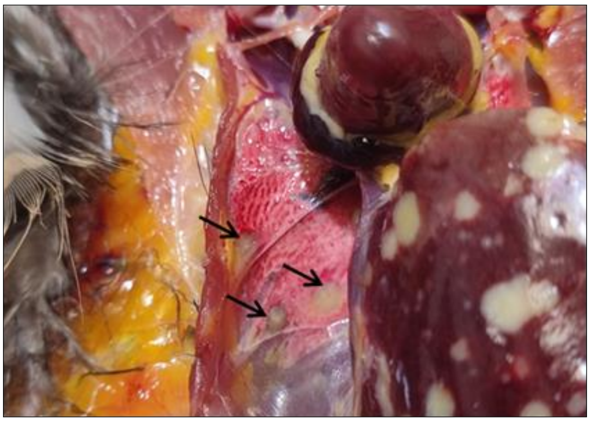


Fig. 2. Pathomorphological changes in the lungs of a pheasant with tuberculosis: multiple TB granulomas in the lung parenchyma

During the study of the digestive organs, we observed the following. The esophagus had no noticeable pathological changes. The proventriculus contained multiple granulomatous formations in the mucous membrane (Fig. 3). Granulomas of grayish-white color and dense consistency were clearly separated from the surrounding tissues, in some regions jutting above the surface of the mucous membrane and thus deforming its relief. The gizzard and the cuticle were intact; the wall had no signs of granulomatous inflammation. On the mesentery, we observed multiple dense granulomas of grayish-white color, distinctly separated from the surrounding tissues. In the wall of the small intestine, we found numerous granulomatous formations of different sizes, localized in the thickness of the wall and in some regions protruding above the surface of the mucous membrane (Fig. 4). The mucous membrane was hyperemic, swollen, and the lumen contained mucus, which is consistent with catarrhal enteritis. The detected changes indicated a combination of specific granulomatous process and exudative inflammation of the mucous membrane.

In the liver parenchyma, we found numerous granulomas of different sizes, grayish-white or yellowish-gray, of dense consistency, and distinct (Fig. 5). The nodules were diffusely arranged across the entire surface and on the cut section of the organ. The morphological picture corresponded to the multiple specific granulomatous hepatitis, with signs of generalization of the infectious process. The pancreas exhibited no macroscopic pathological changes.

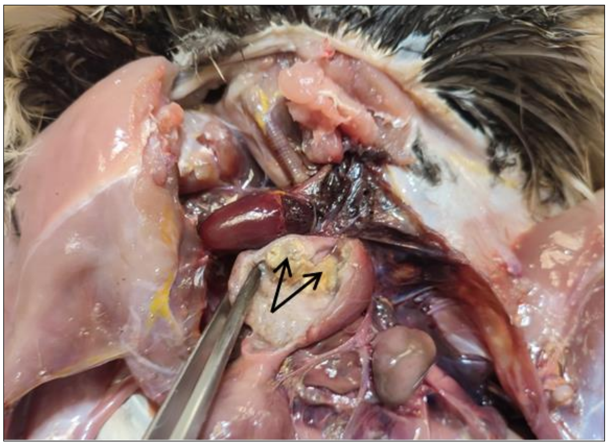


Fig. 3. Pathomorphological changes in the proventriculus of a pheasant with tuberculosis: In the mucous membrane, we noted distinctly separated granuloma of grayish-white color and dense consistency, jutting above the surface of the mucous membrane (the granulomatous inflammation is indicated with an arrow)

The surface of the spleen was uneven due to the protruding nodular formations, and the organ's margins were blunted. In the parenchyma, we saw multiple granulomas measuring up to 10 mm in diameter, of dense consistency, grayish-white, distinctly separated from the surrounding tissue (Fig. 6). On the section, the nodules were well visualized, homogeneous. The morphological picture corresponded to multiple specific granulomatous splenitis and indicated the involvement of an immunocompetent organ in the systemic infectious process.

Fig. 4. Pathomorphologic changes in the small intestine of a pheasant with tuberculosis: multiple TB granulomas of the mesentery and the wall of the small intestine, catarrhal enteritis (the affected areas are indicated with pointers)

The shape and size of the kidneys were preserved; the surface had practically no irregularities, and in some regions we observed slight thickenings or subtle bumpiness, which did not disrupt the general architecture of the organ. On the section, the parenchyma was homogeneous, and the density of the tissue was unaltered. No macroscopic signs of specific granulomatous inflammation were found.

Fig. 5. Pathomorphologic changes in the liver of a pheasant with tuberculosis: multiple TB granulomas in the liver parenchyma (the affected areas are indicated with arrows)

Fig. 6. Pathomorphologic changes in the spleen of a pheasant with tuberculosis: multiple TB granulomas in the spleen parenchyma (the affected areas are indicated with arrows)

During the study of the organs of cardiovascular and nervous systems, no pathological changes were observed. The heart, epicardium, and endocardium exhibited no changes; the myocardium was of homogeneous consistency; no nodular formations were observed.

The hemispheres of the brain were symmetrical, the surface was smooth, and the brain tissue was of homogeneous consistency, with no signs of focal inflammations or hemorrhages.

The study of the locomotor apparatus and the peripheral nervous system revealed the following. The thoracic muscles exhibited pronounced reduction in the volume of the muscular tissue, which corresponds to the general cachexia. The muscular tissue was homogeneous, with no focal inflammations, necrosis, or nodular formations. No features of specific granulomatous process were observed. The structure of the sciatic nerve was preserved, with no visible morphologic changes, thickenings, or nodular formations.

The macroscopic examination of the organs of the reproductive system revealed expressed atrophic changes, which correlate with a long-lasting chronic infectious process and general cachexia. The ovary was reduced in size, the follicular apparatus was drastically empoverished, and the follicles of different development stages were absent or occurred singly. The organ's capsule was smooth, with no densifications or nodular formations. The parenchyma was homogeneous, with no signs of macroscopic granulomatous inflammation. Atrophy of the ovary reflects the long exhaustion of the organism and systemic impact of chronic infection.

The observed complex of changes was characterized by multiple granulomatous inflammations of the lungs, liver, spleen, and intestine, with the process showing signs of generalization. The sum of morphological signs corresponded to the chronic course of tuberculosis, with systemic spread of the pathogen and development of specific productive granulomatous inflammation.

The results of the histological study revealed typical microstructural changes, reflecting the course of a specific granulomatous process. Meanwhile, no pathological changes were detected in the thoracic muscle, esophagus, gizzard, and the sciatic nerve.

In the mucous membrane, the trachea exhibited insignificant diffusive lymphocytic infiltration of the lamina propria. The epithelium was mostly preserved, with no notable destructive changes observed.

The lung tissue exhibited a pronounced hyperemia of the microcirculatory vessels. In the mucous membranes of the bronchi, we observed focal lymphocytic infiltration. In the lung parenchyma, we saw focal necroses and typical granulomatous formations (Fig. 7a). Granulomas had a structure characteristic of tuberculosis and were represented by a central necrotic zone, surrounded by epithelioid cells and perifocal lymphocytic infiltration. Similar epitheliod-cell granulomas also localized in the walls of the parabronchi (Fig. 7a). The sum of the mentioned morphological changes corresponded to the picture of productive granulomatous inflammation, typical for tuberculosis-related pneumonia.

In the myocardium, there was hyperemia of the blood vessels. In the intermuscular connective tissue, we observed an insignificant diffuse lymphocytic infiltration. No expressed destructive or granulomatous changes were seen in the myocardium.

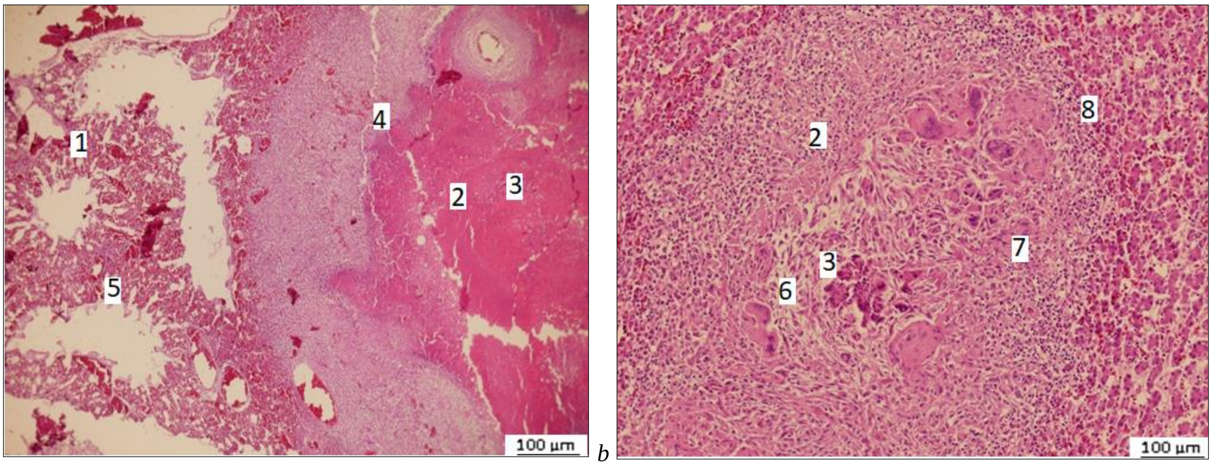
In the pancreas, we observed necrosis of endocrine cells of islets of Langerhans. The peripheral regions of the lobules presented with focal necrotic changes of acinar cells of the exocrine parenchyma.

Multiple focal necroses and granulomatous formations were present in the liver parenchyma. Granulomas had a structure typical for the process of tuberculosis and were composed of a central necrotic zone, surrounded by epithelioid macrophages, multinucleated Langhans giant cells, lymphocytes, and heterophiles. Similar TB granulomas (tubercles) localized in different areas of the hepatic parenchyma and were accompanied by pronounced cellular inflammatory reaction (Fig. 7b). The morphological picture corresponded to specific productive granulomatous inflammation, characteristic of tuberculosis-related damage to the liver.

In the spleen parenchyma, we observed focal areas of fibrinoid necrosis. Different areas of the organ exhibited granulomatous formations, represented by typical tuberculosis granulomas (tubercles). Granulomas had a typical histostructure: The central zone of necrosis was surrounded by epithelioid cells and multinucleated Langhans giant cells, with a notable perifocal infiltration, represented by lymphocytes and heterophils. Granulomatous formations were localized (scattered) in the liver parenchyma and were accompanied by distortions in the normal histoarchitecture of the organ (Fig. 8a). The sum of the detected morphologic changes corresponded to the picture of specific productive granulomatous inflammation, typical for TB-related inflammation of the spleen.

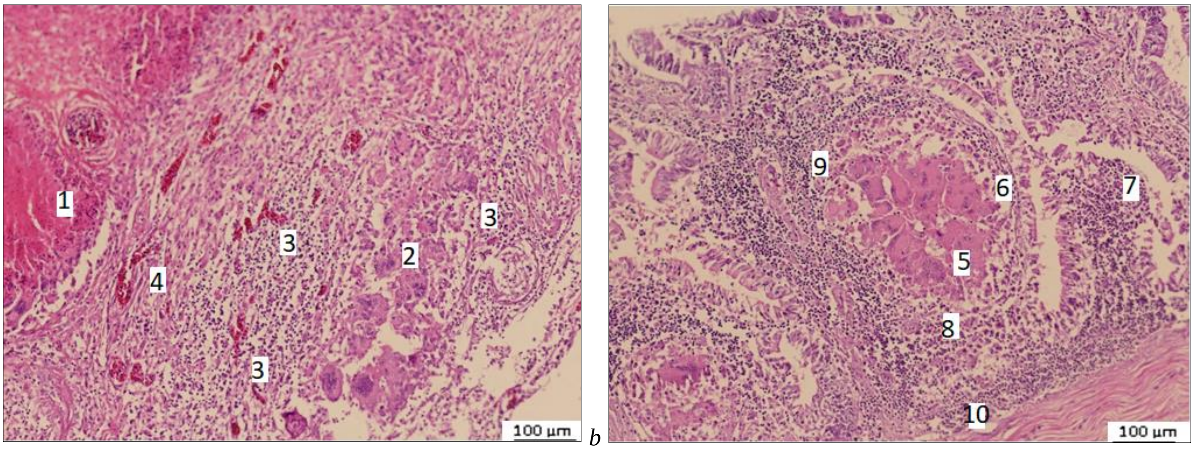
In the mucous membrane of the proventriculus, we noted focal necrotic changes and cellular infiltration, represented mostly by lymphocytes and neutrophils. Inflammatory elements were localized in lamina propria of the mucous membrane and partly between glandular structures. In the regions of inflammatory reaction, we observed single multinuclear/multinucleated cells of macrophagous type.

In the mucous membrane of the small intestine, we saw focal areas of necrosis and typical granulomatous formations (tubercles) (Fig. 8b). Granulomas were represented by a central necrotic zone, surrounded by epithelioid cells, multinucleated Langhans giant cells type, and also lymphocytes and heterophils. The mucous membrane exhibited a diffusive lymphocyte-heterophile infiltration, with necrotic areas and desquamation of the epithelium. In the muscular membrane, we found focal heterophile-lymphocyte infiltration. The sum of the detected changes was consistent with the picture of focal granulomatous-necrotic enteritis, typical for inflammations during intestinal tuberculosis.



a b

Fig. 7. Fragment of the histological structure of the lungs (*a*) and liver (*b*) of a pheasant with tuberculosis: *1* – lymphocyte infiltration of the bronchi; *2* – focal necrosis; *3* – central zone of the granulomas; *4* – perifocal lymphocyte infiltration; *5* – granulomas in the walls of parabronchi; *6* – epitheliod macrophages of granulomas; *7* – Langhans giant cells; *8* – the rim of lymphocytes (perifocal infiltration); staining with Gill II hematoxylin and eosin



a b

Fig. 8. Fragment of the histological structure of the spleen (*a*) and small intestine (*b*) of a pheasant with tuberculosis: *1* – foci of specific inflammation; *2* – multinuclear macrophages; *3* – perifocal lymphocyte infiltration; *4* – parenchyma of the spleen with disorganiation of the histoarchitectonics as a result of granulomatous inflammation; *5* – central necrotic zone of granulomas; *6* – epithelioid cells; *7* –multinucleated Langhans giant cell; *8* – perifocal lymphocyte-heterophile infiltration; *9* – tuberculosis granulomatous nodule in the mucous membrane; *10* – focal inflammatory infiltration in the muscular membrane; staining with Gill II hematoxylin and eosin

In the tissues of the kidneys, a pronounced hyperemia of the microcirculatory vessels was observed. In the collecting duct system, we saw diffuse necrosis of the epithelium of renal tubules, with signs of dystrophic changes. In the intertubular interstitium, focal lymphocytic-heterophilic infiltration was present. Most of the renal glomeruli underwent destructive changes, manifested in disruptions of their structural organization. The sum of the detected morphologic changes corresponded to the picture of interstitial nephritis of lymphocytic-heterophilic type, accompanied by the development of nephrosis.

The microcirculatory vessels of the brain exhibited hyperemia. No pronounced destructive or inflammatory changes were found.

Based on the analysis of the complex of pathomorphologic features, a diagnosis of tuberculosis was established. Considering modern principles of diagnostics of infectious diseases, in order to verify it, we carried out a complex of laboratory studies. At the first stage, we performed bacteriological inoculation from the pheasants' internal organs (heart, liver, spleen) onto a liquid medium, tryptic soy broth (Biolife, Italy), following the generally accepted methods to exclude concurrent infections. The inoculations were cultivated at a temperature of 37.0 °C for 24 and no growth of microorganisms was recorded in any of the cases.

During the microscopic analysis of the histological sections stained using the Ziehl–Neelsen method, we found acid-fast bacteria, stained intensively red and morphologically corresponding to mycobacteria (Fig. 9a, 9b). To verify the yielded results, we conducted a molecular-genetic study using the Real-Time PCR method, in which the analyzed material tested positive for avian tuberculosis / *Mycobacterium avium*. For the purpose of differential diagnostics, we additionally analyzed the samples for the presence of the *Mycobacterium tuberculosis* complex (*M. tuberculosis*, *M. bovis*, *M. africanum*, *M. microti*), whose DNA was not found in the examined material.

Discussion

Despite notable progress in combating mycobacterioses, tuberculosis epidemic is still a global issue (Kock et al., 2021; Szacawa et al., 2025). According to the State Institution Center of Public Health of the Ministry of Health of Ukraine, in 2025, the number of first-time recorded tuberculosis cases in Ukraine, including relapses, accounted for 15,564 cases, which is 14% lower than in 2024. Tuberculosis is a latent threat to the global health and animal populations, which has been a challenge worldwide for over a century now, especially for countries with low and average levels of income. That is why tuberculosis is a disease that reflects the socioeconomic level of life in a country. In this study, we analyzed the peculiarities of pathomorphologic changes during tuberculosis in pheasants, confirmed by detecting acid-fast bacteria in the inflammated areas of the organs and detecting DNA of mycobacteria using the Real-Time PCR method. The issue of timely detection and elimination of the source of tuberculosis among animals in contact with humans, or consumes products obtained from them, is especially important. More reports emerge regarding zoonotic tuberculosis and its threat to humanity (Luciano & Roess, 2020; Woldemariam et al., 2025; Fernández-Huerta et al., 2026). As with the involvement of birds in the epidemiologic process of tuberculosis in people, according to Algammal et al. (2025), *Mycobacterium avium* is often present in soil and water and is the second commonest mycobacterium that infects both animals and humans. Immunocompromised individuals, such as patients with AIDS, are among especially vulnerable groups. Those problems underline the dire need of enhancing the One Health approach, which integrate the systems of healthcare, veterinary, and the safety of food products, which are supported by improved laboratory potential, coordinated monitoring, and targeted measures toward reducing the risks of transmission of zoonotic tuberculosis and support of national goals of combating tuberculosis.

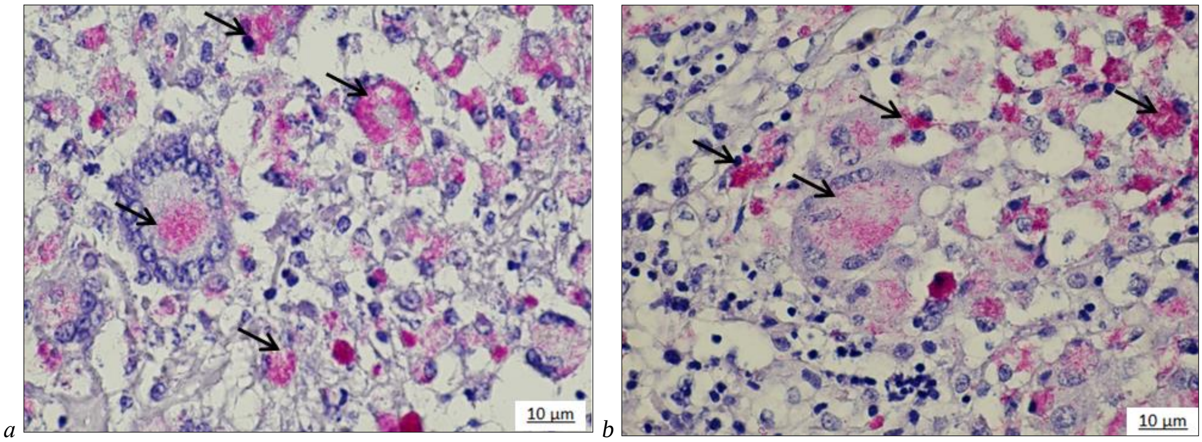


Fig. 9. Fragment of the histological structure of the lungs (*a*) and the spleen (*b*) of a pheasant with tuberculosis (acid-fast mycobacteria, stained red, are indicated with arrows): Ziehl–Neelsen stain

According to numerous studies, inflammations caused by the representatives of *Mycobacterium avium* in birds can occur subclinically or asymptomatically, significantly complicating antemortem diagnostics (Dvorska et al., 2007). Therefore, avian tuberculosis is mostly diagnosed postmortem during necrosis (Maysoon, 2016; Özen et al., 2016; Liakhovych et al., 2020; Salamatian et al., 2020).

According to the scientific literature, classical pathomorphologic features of avian tuberculosis are considered to be granulomatous inflammations of the liver and spleen, caseous necrosis of the intestinal wall, and also caseous pneumonia (Liakhovych et al., 2020). At the same time, in contrast to mammalian tuberculosis, lung damage in birds is much rarer, whereas the pathological process localizes in the organs of digestive system, liver, and spleen. A distinctive morphologic feature is the formation of granulomas without calcification, which distinguishes avian tuberculosis from similar processes in other species (Dhama et al., 2011).

Overall, the results we yielded are consistent with the literature data regarding the prevailing damages to the liver, spleen, and intestine, where typical tuberculous granulomas with central necrosis were found. Meanwhile, in contrast to most described cases, the study of pheasants revealed pronounced pulmonary inflammations, with formation of multiple granulomatous nodules, indicating a generalized pattern of the infectious process. The involvement of the lungs in the pathological process may be attributed to species peculiarities of pheasants, conditions of their housing conditions, or prolonged persistence of the pathogen in the organism. Moreover, it is possible that under the conditions of generalization of infectious process, there occurs hematogenous or lymphogenic dissemination of mycobacteria from primary hotbeds in the digestive tract to the organs of the respiratory system. At the same time, we should take into account that the degree of inflammation in individual organs can vary depending on the stage of development of pathological process and individual peculiarities of the bird organism.

According to the data of other authors, tuberculosis in domestic and wild birds most often has enteral-hepatic pattern, with pathogen further dissemination to other organs, including the spleen, bone marrow, lungs, and skin (Mariappan et al., 2023). In wild fauna, in particular birds of prey, the disease often occurs in a generalized form, affecting the digestive system and parenchymal organs (Heatley et al., 2007; Millan et al., 2010).

Pathogenesis of avian tuberculosis is divided into three stages: latent, development of morphological lesions, and cachexia, accompanied by the formation of large granulomas with a large amount of mycobacteria (Tell et al., 2011; Dvorska et al., 2013). Pronounced cachexia, found in the examined pheasants, was probably a consequence of long-lasting infectious process and chronic intoxication of the organism. According to the literature, the development of exhaustion during avian tuberculosis is associated with impairments of protein-energy metabolism, systemic inflammatory reaction, and damage to the organs of the digestive system, causing a progressing decline in body mass and overall exhaustion of the organism (Dhama et al., 2011; Zhang et al., 2025).

The clinical signs of tuberculosis in birds are not pathognomonic and to a high degree depend on the localization of the pathological process. In the early stages of the disease, they are often absent, whereas during the progressing pathological process, there can be observed progressing exhaustion, diarrhea, lethargy, decline in the productivity, and rarer respiratory disorders (Gerhold & Fischer, 2005). This again underlines the importance of pathomorphological studies as a key diagnostic method.

Typical tuberculosis-related inflammations in birds are represented by dense grayish-white or yellowish nodules, most often localizing in the intestines, liver, and spleen. At the same time, granulomas have a caseous nature, without a tendency toward calcification, and the affected organs are oftentimes increased in volume (Manarolla et al., 2009; Schmidt et al., 2022). The morphological data we obtained are fully consistent with those characteristics, and likewise supplement them with a detailed description of the microstructural organization of granulomas and accompanying dystrophic and necrotic changes in different organs.

The yielded results are in line with the modern understanding of the pathomorphology of avian tuberculosis. Likewise, they supplement them with the information pertaining to the variability of the localization in the organs and the degree of generalization of infectious process in pheasants. This contributes to the elucidation of morphological criteria for diagnostics and enhances the understanding of pathogenetic mechanisms of the disease's development.

Conclusions

The conducted studies revealed that tuberculosis in pheasants is characterized by a generalized course, with formation of typical tuberculosis / tuberculous granulomas in different organs and systems. The detected pathomorphologic changes had a pronounced productive-necrotic pattern and reflected the development of systemic infectious process, accompanied by cachexia and progressing exhaustion of the organism.

A combination of macroscopic and microscopic studies allowed us to make a detailed description of the structural peculiarities of inflammations and verify the diagnosis of tuberculosis, which is consistent with the results of molecular-genetic methods, in particular, the identification of *Mycobacterium avium*.

We determined that the pathomorphological method plays a key role in diagnostics of avian tuberculosis, especially in the conditions of latent and low-symptom course of infectious process, when clinical manifestations are minimal or nonspecific. The obtained results expand the modern understanding of the spectrum of morphologic changes in tuberculosis of pheasants, highlighting the variability of the organ inflammations and the stages of the pathological process. This additionally substantiates the diagnostic significance of a complex approach, combining pathomorphological and molecular-genetic methods of study.

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