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Diversity of gastrointestinal parasites of turkeys (*Meleagris gallopavo*) under different housing systems in Bessarabia, Ukraine

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Summary

The development of turkey farming is significantly restrained by parasitic diseases, which have become widespread and cause significant economic losses to specialized- and homestead farms. This study aimed to determine the prevalence of endoparasites in turkeys of different age groups under different maintenance systems and the nature of patho-anatomical changes depending on the course of the disease. A total of 1,869 samples of fecal from turkeys were studied. From turkeys kept in poultry houses, 925 fecal samples and 944 fecal samples from free-range turkeys were examined. In turkeys that were kept in a poultry house, the total infection with endoparasites was 59.8 %, while in free range, it was 63.3 %. The most common in turkeys 30-60 days old from poultry houses are *Histomonas meleagridis* (21.5 %), *Eimeria* spp. (11.5 %) and *Cryptosporidium baileyi* (15.5 %) and in free-range turkeys – *Histomonas meleagridis* (15.6 %), *Eimeria* spp. (7.2 %) and *Cryptosporidium baileyi* (10.8 %). *Cryptosporidium baileyi* was not observed in turkeys 360 days old or older. *Tetratrichomonas gallinarum* was most frequently recorded in turkeys 90 – 120 days old from poultry houses (3.8 %) and turkeys 150 – 180 days old in free range (3.7 %). *Ascaridia dissimilis* is most common in free-range turkeys 90 – 120 days old (11.8 %) and turkeys 150 – 180 days old from poultry houses (9.5 %). *Heterakis gallinarum* was primarily recorded in turkeys 150 – 180 days old under both systems of keeping with a value range from 16.2 to 17.2 %. Infestation of 150 – 180-day-old free-range turkeys by cestodes *Davainea meleagridis* and *Raillietina echinobothrida* was 15.0 % and 12.9 %, respectively. Thus, the diversity and prevalence of gastrointestinal tract invasions depend on the age and housing system of the poultry.

Keywords: age; gastrointestinal parasites; type of housing; turkeys; prevalence

Introduction

Turkey farming is one of the most intensive and dynamic branches of poultry farming, producing dietary and high-calorie meat and eggs. At the same time, the development of turkey farming is significantly restrained by parasitic diseases, which have become widespread and cause significant economic losses to specialized and homestead farms (Bogach *et al*., 2016).

The number of breeding and commercial turkey farms in Ukraine has recently decreased somewhat, while the population in backyard farms has increased significantly (Khariv, 2013).

Backyard or rural "family poultry farming" is a form of traditional domestic animal husbandry that requires few resources and includes various types of birds, such as chickens, turkeys, ducks,

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geese and quails, and is the most traditional and widespread activity in rural communities, as this benefits rural families by providing high-nutrient foods such as meat and eggs, as well as surplus income (Centeno-Bautista *et al*., 2007; Avilés *et al*., 2019).

Gastrointestinal (GI) parasites are considered a major problem in poultry production, leading to economic losses due to reduced productivity, feed digestibility and poor weight gain, reduced egg production, anorexia, diarrhea, intestinal obstruction, emaciation, anemia, paralysis, poor plumage and even deaths (Jegede *et al*., 2015; Divyamery *et al*., 2016; Balarabe *et al*., 2017).

Parasites commonly infect various bird species' gastrointestinal tracts, such as helminths and protozoa (Bayzid *et al*., 2023).

Helminth parasites of poultry are usually cestodes, nematodes, and trematodes, among which nematodes are considered the most important group in terms of the number of species and the damage they cause. Only a small number of cestodes and trematodes are known to parasitize domestic and wild birds (McJunkin *et al*., 2003; Udoh *et al*., 2014; Goria *et al*., 2018).

Eimeria is a major gastrointestinal protozoan affecting all poultry species (Lawal *et al*., 2016; El-Shall *et al*., 2022). Young birds affected by gastrointestinal parasites show severe clinical disease. In contrast, adult birds can sustain the parasitic infection and act as a reservoir to maintain continuous environmental contamination and circulation of the infestation among all bird species (Singh *et al*., 2017).

Histomonas meleagridis is a flagellate protozoan parasite that inhabits the caecum of poultry and causes high mortality in turkeys, sometimes approaching 100 % of the flock (McDougald *et al*., 2005). Although PCR confirmed the presence of the parasite in most tissues of infected birds, the caecum and liver appeared to be the most favorable sites (Huber *et al*., 2006).

Cryptosporidium baileyi is a zoonotic pathogen that causes respiratory symptoms in chickens for which no effective control measures currently exist (Wu *et al*., 2021). C. baileyi and C. meleagridis usually cause cryptosporidiosis in chickens and/or turkeys. *C. baileyi* is generally the most common species in poultry, causing respiratory and intestinal infections (including histopathological changes in the bursa of Fabricius) (Ramirez *et al*., 2004).

Tetratrichomonas gallinarum is known as one of the protozoan organisms that parasitizes the caecum of chickens (Amin *et al*., 2014) and turkeys (Hauck *et al*., 2010).

There are many reasons for disease occurrence. The timely identification of the disease pathogen is essential. The time spent on making a laboratory diagnosis of the disease and delivering the research results to poultry owners often exceeds the time required to develop the invasive process in poultry flocks. It does not allow the necessary measures to be taken in time (Bogach *et al*., 2021). Therefore, the study of the variety of pathogens and the prevalence of gastrointestinal invasions in relation to turkeys' age and housing system is relevant.

The aim of the research is to study the distribution patterns and diversity of gastrointestinal parasites in turkeys of different age groups were kept in poultry houses and under a cage-pasture management systems.

Materials and Methods

Sampling time and study locations

In total, from March to December 2023, 1,869 fecal samples of turkeys of different age groups were studied by coproscopy methods. The number of poultry in poultry houses was from 1100 to 2500, and in free-range farms - from 90 to 320 turkeys. The main criteria for selecting fecal samples were lack of appetite in the bird, liquid fecal and hypodynamia. In the parasitological laboratory Odessa Research Station of the National Research Center "Institute of Experimental and Clinical Veterinary Medicine," 925 samples of fecal from turkeys kept in poultry houses were examined, namely from three farms in the city of Izmail (90–120 days of age, n=318;

Fig. 1. Cities of Bessarabia (Ukraine) in which turkey farms were studied.

150–180 days of age, n=220; 360 and > days of age, n=117) and from one farm in the city of Bilhorod-Dnistrovskyi (30–60 days of age, n=270). From turkeys in free-ranging, 944 fecal samples were examined, namely from 8 farms in the city of Utkonosivka (n=370), three farms in the city of Kilia (n=210), two farms in the city of Vylkove (n=150) and three farms in the city of Bolgrad (n=214) (Fig. 1).

Coproscopic studies

Fecal samples were collected from the floor and pasture with a spatula, which was washed after each collection. Each fecal sample was placed in a container and labeled with the date, age of the bird, and method of keeping.

Pathological autopsy of dead turkeys (n=51) was performed at the Department of Pathological Anatomy of Odesa State Agrarian University.

The alimentary canal was opened using sterile scissors from the esophagus to the rectum, and all helminths visible to the naked eye were collected using forceps (Fatihu *et al*., 1992). Scrapings from the intestinal mucosa from the upper, middle and lower parts and cecum were preserved with a 3 % formalin solution (Cheesbrough, 2010).

Examination of feces was carried out using the native smear method. Feces were thoroughly mixed in a beaker with a 50 % water-glycerin solution in a ratio of 1:1. Then, a drop of the obtained suspension was placed on a slide covered with a cover glass and examined under a microscope (magnification ×80 and ×400, Carl Zeiss, Germany) to detect and identify the pathogens *Eimeria* spp., *Histomonas meleagridis* and *Tetratrichomonas gallinarum*. In order to identify pathogens, scrapings of the mucous membrane of the large intestine and cecum (*H. meleagridis* and *T. gallinarum*), small intestine (*T. gallinarum*), smears-imprints from the affected organs were examined microscopically. Smears-imprints were fixed with methanol for 3 – 5 minutes and stained according to the Romanovsky-Giemsa method. Regarding trichomonads identification, smears were air-dried and stained with methylene blue, which made it possible to identify parasites by morphological features (Menezes *et al*., 2016).

Eggs of *Ascaridia* spp. and *Heterakis* spp. were differentiated by observing the morphology and micrometry of their eggs. Egg size of Ascaridia spp. is 75 – 80 μm × 40 – 50 μm, while Heterakis spp. is 63 – 75 μm × 36 – 48 μm (Urquhart *et al*., 1996).

To identify *Cryptosporidium baileyi*, native smears were stained with safranin, according to Kester and examined under an immersion microscope system (eyepiece 10×objective 90). Cryptosporidium oocysts were pink-orange on a green background.

Differentiation of oncospheres of Davainea meleagridis and Raillietina echinobothrida was performed by staining cestodes eggs with diamond green in a dilution of 1:10000 for 3 – 5 minutes exposure. In a humid environment, the lumen between the chorion and the oncosphere membrane expands in the egg of Davainea proglottina, which becomes swollen and correspondingly stained light green, while in Raillietina spp. only the outer shell (chorion) was stained (Bohach *et al*., 2013).

The prevalence of parasitosis was determined by the indicator of extensiveness of invasion (EI, %) and was calculated according to the formula:

$EI = n/N \times 100\ \%$,

where n is the number of infested animals;

N is the number of studied animals.

Pathoanatomical studies

Autopsies of turkey carcasses were performed in the section hall

Table 1. Prevalence of endoparasites in turkeys of different age groups kept in poultry houses in the Bessarabia in 2023.

Parasite	30-60 days old, n=270		90-120 days old, n=318		150-180 days old, n=220		360 and > days old, n=117	
	Infected	Prevalence (%)	Infected	Prevalence (%)	Infected	Prevalence (%)	Infected	Prevalence (%)
Protozoans								
Histomonas meleagridis	58	21.5	56	17.6	13	5.9	8	6.8
Eimeria spp.	31	11.5	12	3.8	7	3.1	2	1.7
Cryptosporidium baileyi	42	15.5	9	2.8	3	1.4	–	–
Tetratrichomonas gallinarum	9	3.3	12	3.8	8	3.6	1	0.8
Nematodes								
Ascaridia dissimilis	8	3.0	27	8.5	21	9.5	4	3.4
Heterakis gallinarum	26	9.6	53	16.6	38	17.2	12	10.3
Capillaria spp.	6	2.2	21	6.6	12	5.5	3	2.5
Cestodes								
Davainea meleagridis	3	1.1	18	5.6	14	6.3	4	3.4
Raillietina echinobothrida	–	–	8	2.5	11	5.0	3	2.5

of the Department of Normal and Pathological Morphology and Forensic Veterinary Medicine of Odesa State Agrarian University. Various parameters were used to determine macroscopic changes in organs. When examining the liver, the shape, size, appearance of the internal structure (in section), consistency, degree of blood filling were determined. In the intestinal tube, the thickness of the wall, the patency of the intestinal tube, the presence or absence of damage and its degree were determined; the nature of the content (amount, condition, consistency, color).

Ethical Approval and/or Informed Consent

The research program was reviewed and approved by the bio-ethics commission of the National Research Center "Institute of Experimental and Clinical Veterinary Medicine."
The entire experimental part was carried out in compliance with the international principles of the European Convention "On the Protection of Vertebrate Animals Used for Experiments and Other Scientific Purposes" (Strasbourg, 1985; Simmonds, 2018; Kabene & Baadel, 2019; Festing & Wilkinson, 2007).

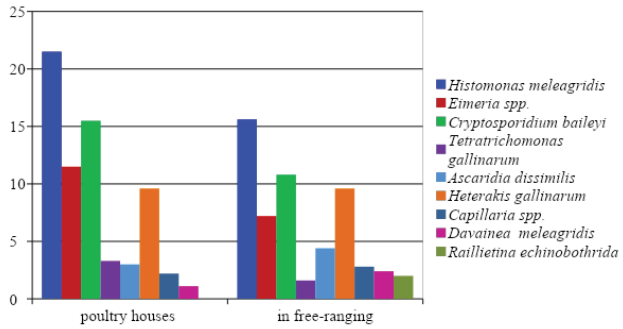
Results

In turkeys of different age groups, which were kept in a poultry house, the total infestation with endoparasites was 59.8 %. The extensiveness of endoparasitoses in turkeys 30 – 60 days old was 67.7 %, turkeys 90 – 120 days old – 67.9 %, turkeys 150 – 180 days old – 57.7 %, and adult birds older than one year - 23.0 %. Turkeys 30 – 60 days old were most affected by protozoa - 51.8 %, while nematode infection was 14.8 % and only 1.1 % by cestodes (Table 1).

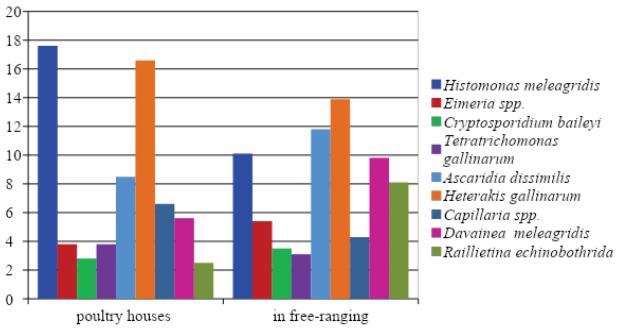
Nematodes were detected in 31.7 % 90 – 120 days old turkeys, protozoa in 28.0 % of turkeys, and cestode infestation increased to 8.1 %, compared to 30 – 60 days old turkeys. The damage caused by nematodes 150 – 180 days old in turkeys was the greatest and amounted to 32.2 %. Protozoans were 14.0 %, and cestodes 11.3 %. Adult 360-day-old turkeys and older were most affected by nematodes (16.1 %), and only 9.3 % of the birds were infested with protozoans and 5.5 % with cestodes.
When turkeys of different age groups were kept on pasture, the total infestation by endoparasites was 63.3 %. Infestation 30 – 60 days old of turkeys by endoparasites was 56.4 %, 90 – 120 days old 71.3 %, 150 – 180 days old 68.7 %, and 360 days old 45.4 %. It was established that 35.2 % of turkeys aged 30–60 days were infested with protozoans, 16.8 % with nematodes and 4.4 % with cestodes (Table 2).
Turkeys 90 – 120 days old were affected by nematodes (30.1 %,) protozoans (22.3 %), and cestodes (17.9 %). The extent of damage to turkeys 150 – 180 days old was high, with cestodes 27.9 %, nematodes 27.5 %, and protozoans only 13.3 %. Adult 360-day-old turkeys and older were also mostly infested with cestodes (18.5 %) and nematodes (17.6 %). Infestation with protozoans was 9.3 %.
In 30–60 days old of turkeys that were kept in poultry houses, the lesions of *Histomonas meleagridis* were registered on 5.9 % more, *Cryptosporidium baileyi* and *Eimeria* spp. on 4.7 % and 4.3 %, respectively, than in free-range turkeys. The prevalence of cestodes *Davainea meleagridis* and *Raillietina echinobothrida*, a potentially pathogenic parasite in turkeys, was very low (less than 2.4 %) (Graph 1).
When keeping 90 – 120 days-old turkeys in the poultry house, *H. meleagridis* was 7.5 % higher than in free-ranging turkeys.

Table 2. Prevalence of endoparasites in turkeys of different age groups kept in free-ranging in the Bessarabia in 2023.

Parasite	30-60 days old, n=250		90-120 days old, n=346		150-180 days old, n=240		360 and > days old, n=108	
	Infected	Prevalence (%)	Infected	Prevalence (%)	Infected	Prevalence (%)	Infected	Prevalence (%)
Protozoans								
Histomonas meleagridis	39	15.6	35	10.1	11	4.6	5	4.6
Eimeria spp.	18	7.2	19	5.4	11	4.6	2	1.8
Cryptosporidium baileyi	27	10.8	12	3.5	1	0.4	–	–
Tetratrichomonas gallinarum	4	1.6	11	3.1	9	3.7	3	2.7
Nematodes								
Ascaridia dissimilis	11	4.4	41	11.8	14	5.8	6	5.5
Heterakis gallinarum	24	9.6	48	13.9	39	16.2	9	8.3
Capillaria spp.	7	2.8	15	4.3	13	5.4	4	3.7
Cestodes								
Davainea meleagridis	6	2.4	34	9.8	36	15.0	11	10.2
Raillietina echinobothrida	5	2.0	28	8.1	31	12.9	9	8.3



Graph 1. Prevalence of endoparasites in turkeys 30 – 60 days old in the Bessarabia in 2023.



Graph 2. Prevalence of endoparasites in turkeys 90 – 120 days old in the Bessarabia in 2023.

H. gallinarum eggs were recorded at almost the same level, while *R. echinobothrida* was higher at 5.6 %, *D. meleagridis* at 4.2 % and *A. dissimilis* at 3.3 % (Graph 2).

It was visually established that in the intestinal form of histomonosis, the wall of the caecum was unevenly thickened due to edema hyperemic with individual dotted and striped hemorrhages (Fig. 2). In the fundal part of the cecum, mushroom-like and nodular formations of various shapes and sizes were found, clearly distinguished above the surface of the mucous membrane. In some cases, these formations merged with each other and formed a so-called solid "cheesy" mass. Damage to its integrity, as well as minor dotted and streaked hemorrhages, were observed in places where the cheesy mass was tightly attached to the intestinal mucosa.

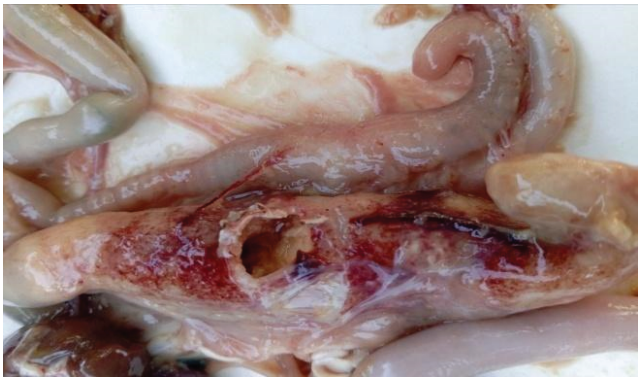


Fig. 2. Inflammation of the caecum with perforation of the wall during the acute course of histomonosis in turkeys 90 – 120 days old.

Penetration of histomonads into blood vessels led to a violation of hemodynamics in the intestinal wall due to the formation of blood clots and a violation of the permeability of the vascular wall, which led to hyperemia and hemorrhages in the mucous membrane, as well as to severe swelling of the submucosal layer.

In the hepatic form of histomonosis, pronounced patho-anatomical changes were recorded, characterized by noticeable grayish-white nodules, the size of which is from a millet grain to a pea (Fig. 3). Such nodules had clear boundaries between healthy liver tissue and slightly protruded on the surface of the capsule, which penetrated deeply into the liver parenchyma. The edges of the liver are slightly rounded, have a flabby consistency, and the capsule is tense.

At the pathological autopsy of turkeys affected by *A. dissimilis*, from 9 to 35 nematodes were recorded, as well as thickening and swelling of the small intestines (Fig. 4).

The course of the disease was characterized by catarrhal-dystrophic and destructive processes, accompanied by a pronounced vascular reaction, hemorrhages and desquamation of the covering epithelium. A significant accumulation of lymphoid tissues was recorded at the base of the mucous membrane.

In turkeys 150 – 180 days old, infestation by protozoa significantly decreased, regardless of the housing system (Graph 3).

The extensiveness of *H. gallinarum* differed by only 1 %, while the infestation in free-ranging turkeys on *D. meleagridis* cestodes increased by 8.7 % and *R. echinobothrida* by 7.9 %.

Cryptosporidium baileyi oocysts were not recorded in adult turkeys 360 days old and older (Graph 4).

The extensiveness of *Eimeria* spp. and *T. gallinarum* was very low (less than 2.7 %). *H. gallinarum* nematode infestation of turkeys in the poultry house was only 1.9 % higher than by free-ranging, while *A. dissimilis* infestation of poultry was, on the contrary, 2.1 %

Fig. 3. Miliary necrosis of the liver during the chronic course of histomonosis in turkeys 90 – 120 days old.

Fig. 4. The small intestine of 90 – 120 days old turkey infected with *Ascaridia dissimilis*.

higher. Also, in free-ranging turkeys, infestation to *D. meleagridis* increased by 6.8 % and R. echinobothrida by 5.8 %, compared to birds kept in a poultry house.

When dissecting the turkey's small intestine, 18 cestodes of *R. echinobothrida* were recorded (Fig. 5).

The main pathomorphological changes in raietinosis were characterized by a violation of the integrity of villi and crypts in the small intestine of turkeys, as well as the formation of parasitic nodules in the places of fixation of cestodes. In the place of fixation of *R. echinobothrida*, the tissues of the intestinal wall were compacted and necrotic.

In the case of Davainea meleagridis, turkeys' damage, inflammation and mucous membrane thickening were recorded in the small intestines (Fig. 6).

The small intestine's mucous membrane was bright red, and spot hemorrhages were recorded in some of its areas. Fibrinous layering was recorded on the mucous membrane, sometimes with blood impurities on the wall and a large amount of mucus in the intestines' lumen.

Discussion

Statistical data show that more than 90.0 % of the turkey population in Ukraine use walking areas and pastures where birds of different ages and species categories are kept together. Contact with other domestic and wild birds significantly spreads invasive diseases (Bogach, 2010).

Poultry kept in cages is always highly susceptible to intestinal parasitic infections, especially protozoa and nematodes, which are the most common (Peng *et al*., 2021).

Indoor poultry support is widely used, as it is believed that a higher infection rate is recorded in an extensive system of housing (21.46 %) compared to a semi-intensive system (6.82 %) (Agmas *et al*., 2022).

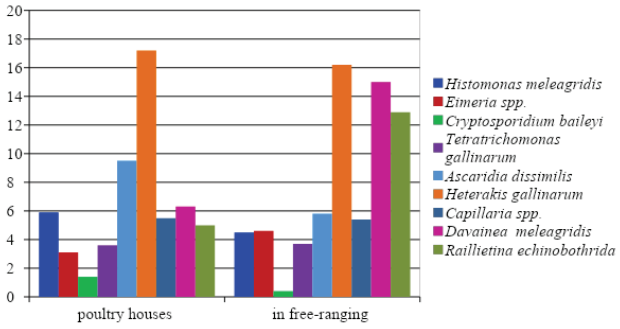
Parasite prevalence in captive birds is directly proportional to cage sanitation and affects endoparasite populations at high densities (Hasan *et al*., 2018). According to our results, the total infestation of turkeys with endoparasites in cages was 59.8 %, while Mohammed *et al*. (2017) reported 40 % of gastrointestinal infections in turkeys in Abuja, Nigeria.

The total percentage of turkeys infected with gastrointestinal parasites in Erbil city was 35.21 %. Five species of nematodes were registered: *Heterakis gallinarum* 28 %, *Capillaria* spp. 24 %, *Trichostrongylus* spp. 16 %, *Strongyloides avium* 12 % and *Ascaridia galli* 4 %. In addition, *Eimeria* spp. was diagnosed with an infection rate of 48 % (Khalaf *et al*., 2022).

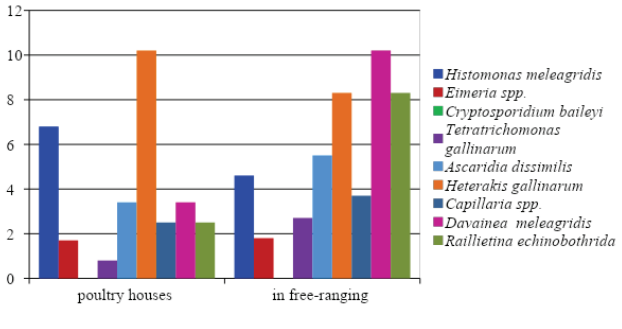
In northern Iran, in the city of Amola, 75 % of slaughtered turkeys were infected with nematodes, cestodes and trematodes, namely 20 % *Capillaria*, 51 % *A. gali*, 8 % *R. tetragona*, 8 % *R. echinobothrida* and 11 % *Echinostoma* (Banadory *et al*., 2014).

Our data shows no *Cryptosporidium baileyi* oocysts were recorded in adult turkeys 360 days old and older. Instead, 10.3 % of turkeys were infected with *Heterakis gallinarum* and 10.2 % of birds were infected with *Davainea meleagridis*.

The level of infection in poultry is related to differences in environmental conditions, climatic, seasonal and meteorological variations, the number of birds examined, the types of breeding and rearing, and the diagnostic methods used (El-Sayed *et al*., 2020).



Graph 3. Prevalence of endoparasites in turkeys 150 – 180 days old in the Bessarabia in 2023.



Graph 4. Prevalence of endoparasites in turkeys 360 days old and older in the Bessarabia in 2023.

Fig. 5. The small intestine of a 360-day-old turkey infected with *Raillietina echinobothrida*.

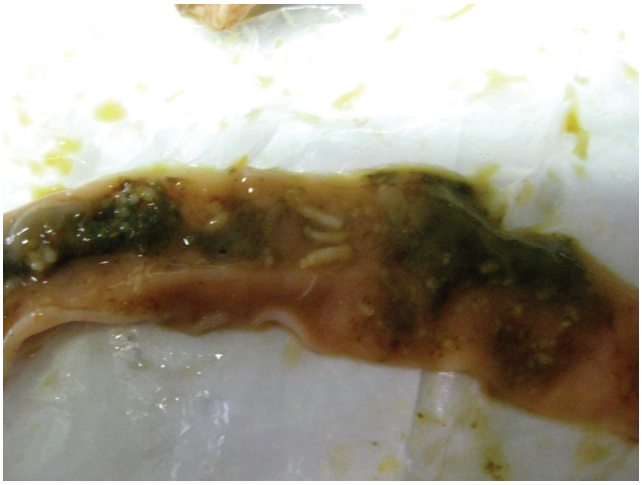


Fig. 6. The small intestine of a 360-day-old turkey infected with *Davainea meleagridis*.

Endoparasites strongly influence birds' behavior and ecological interactions (Abdu *et al*., 2022). In poultry, *A. galli*, *C. annulata* and *H. gallinarum* are considered the main parasites that spread invasive diseases such as ascariasis and cestodosis (Al-Badrani *et al*., 2023). *A. galli* is a highly pathogenic and widespread parasite worldwide (Faraj *et al*., 2020) in poultry species such as pigeons, turkeys, and chickens, which leads to reduced growth and egg-laying rates of birds, ultimately causing significant economic losses in poultry farming (Ara *et al*., 2021).

Parasitic nematode species commonly cause severe infections of birds' gastrointestinal tracts (Al-Quraishi *et al*. 2020). Hasan *et al*. (2018) also reported *A. galli* in turkeys with an extent of 12.5 %, almost similar to the prevalence recorded in our study at 11.8 %. They recorded 25 % of *E. maxima* cases in turkeys, while we recorded a maximum rate of 11.5 % in turkeys 30–60 days old when kept in a poultry house.

A. galli is a widespread nematode that is a common problem for poultry health (Yousaf *et al*., 2019). The nematode *Ascaridia* causes an increase in feed conversion ratio and suppression of the immune system, leading to increased co-morbidities in poultry (Wongrak *et al*., 2014).

Raillietina echinobothrida is one of the most common pathogenic tapeworms worldwide, which causes distinct intestinal nodules in their hosts (Al-Marsomy *et al*., 2016; Bogach *et al*., 2020).

In Punjab, Pakistan, turkeys were infested with *R. echinobothrida* (78 %), *A. galli* (69 %), *Capillaria annulata* (59 %), *C. anatis* (53 %), *E. maxima* (43 %), *H. gallinarum* (36 %), *H. meleagridis* (28 %) (Saim *et al*., 2023).

The pathogenesis of histomonosis begins with colonization of the cecum by the parasite, which leads to severe inflammation and necrosis. After destroying the intestinal tissue, the parasite can enter the blood vessels and reach the liver through the portal veins. As a result, inflammation and destruction may occur in the liver. In the final stage, the disease can become systemic when the parasite spreads to different organs of the bird (Grabensteiner *et al*., 2023). Because the parasite multiplies efficiently in infected birds, intra-flock transmission can occur rapidly, as demonstrated experimentally (Landman *et al*., 2015). Recent research demonstrated that histomonosis could spread rapidly through a flock of turkeys by direct contact, probably involving the phenomenon of cloacal drinking (McDougald, 2005). In any case, the bioprotection effect against introducing histomonads depends on the housing system. It is very limited in free-range flocks or poultry houses that cannot be completely closed (Liebhart *et al*., 2017).

Turkeys infected with *H. meleagridis* had significantly enlarged cecum with thickened walls and their lumens filled with fibrinous material, as well as swollen livers with numerous rounded areas of necrosis, with the entire liver affected in most cases (Hess *et al*., 2006). In broiler turkeys infected with *H. meleagridis*, sudden death was observed at the end of the 5th week without specific clinical signs. An autopsy of 15 affected turkeys revealed severe caecal lesions characterized by thickening of the caecal walls filled with necrotic and caseous material. In addition, multiple cecal tears and necrosis were observed, along with localized peritonitis (Grafl *et al*., 2011).

A large number of outbreaks of histomonosis on standard turkey farms in France have been reported in birds between four and eight weeks of age, but there have been cases in three-week-old birds and some in birds under 17 weeks of age (Callait-Cardinal *et al*., 2010). Some species of *Eimeria* that can infect turkeys include *Eimeria meleagridis, E. meleagrimitis, E. dispersa, E. gallopavonis, E. adenoids,* and *E. innocua*. Infection with *E. adenoids* and *E. meleagrimitis* can cause malabsorption, reduced feed intake, reduced growth, dehydration, poor feed conversion and high mortality (Chapman, 2008).

According to our data, 11.5 % of turkeys 30 – 60 days old in poultry houses and 7.2 % in free-ranging conditions were infested with *Eimeria* spp.

Samples of the genus *Eimeria* spp. were present in 100 % of the gastrointestinal tract of turkeys; the more significant number of oocysts was in the large intestine (88 %) and in the small intestine - only 12 % (Martinez-Guerrero *et al*., 2010).

In a commercial herd, turkeys were infected with moderate levels of *A. dissimilis* but not *H. gallinarum*. Compression smears from liver tissues showed the typical histotrophic phase of *H. meleagridis*, while smears from the caecum showed abundant *Trichomonas gallinarum* (Norton *et al*., 1999).

Endogenous stages of development of *Cryptosporidium meleagridis* were detected in 42.6 % of turkeys in the Central Czech Republic. Asexual stages (meronts at various stages of development) were first sporadically observed in 23-day-old birds. The maximum number of infected turkeys (63.3 %), in which all stages of development of *C. meleagridis* were localized, primarily in the ileum and caecum, were aged 30 – 39 days (Pavlásek, 1994).

According to our research, when turkeys 30–60 days old were kept in poultry houses, *C. baileyi* was recorded in 11.5 % of birds, while on farms in Algeria, 13 % of broiler turkeys were infected with *C. meleagridis* (Laatamna *et al*., 2017).

A large gathering of poultry in limited areas, violations of feeding and keeping of poultry, and changes in temperature, humidity and other parameters of the external environment lead to a decrease in the protective barrier of poultry, the development of many infections and invasions due to the activation of opportunistically pathogenic microflora and potential conditions for the development of bacterial, viral and endoparasitic diseases (Cadmus *et al*., 2019).

Therefore, knowledge about the distribution, extensiveness and intensity of gastrointestinal parasites in turkeys is a fairly well-argued indicator when planning and carrying out treatment and preventive measures.

Conclusion

The distribution and intensity of endoparasitoses in turkeys is affected by the bird's age and type of keeping. It has been proven that in Bessarabia (Ukraine), endoparasites of turkeys are pretty common invasive diseases, the causative agents of which are *Histomonas meleagridis, Eimeria spp., Cryptosporidium baileyi, Tetratrichomonas gallinarum, Ascaridia dissimilis, Heterakis gallinarum, Capillaria spp., Davainea meleagridis* and *Raillietina echinobothrida*.

When turkeys were kept in poultry houses, 51.8 % of poults aged 30 – 60 days were affected by protozoans, while 31.7 % of turkeys aged 90 – 120 days, 32.2 % of turkeys aged 150 – 180 days, and 16.1 % of turkeys aged 360 days and older were infested with nematodes.

Under a cage-pasture management system, 35.2 % of poults aged 30 – 60 days were affected by protozoans, 30.1 % of turkeys aged 90 – 120 days, and 27.5 % of turkeys aged 150 – 180 days were infested with nematodes, and 18.5 % of turkeys aged 360 days and older were affected by cestodes.

In acute histomonosis in turkeys, lesions of the cecum with perforation of the intestinal wall are observed, while in chronic cases, liver lesions with necrotic foci develop.

Conflicts of Interests

The authors declare no conflict of interest in conducting this study. The authors have no conflict of interest when submitting an article to Helminthologia.

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