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Endoparasic diseases of ostriches in eastern Ukraine

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In ostrich farming is difficult to obtain the necessary production and economic results without protection of bird health. We determined the incidence of parasitic ostriches during the period of growing and keeping on specialized eco-zoos. Samples from small and large farms, as well as eco-parks in Kharkiv, Dnepr and Donetsk regions of Ukraine, were examined during 2016-2020. We performed a parasitological study of 159 samples from three species of ostriches (black African ostrich, Australian common Emu (Dromaius), Rhea). Infestation of ostriches of different ages with two types of nematodes and Eimeria was established. We determoined that the population of ostriches in specialized farms and eco-zoos was infested with nematodes and protozoa with an extensiveness of invasion from 7.7% to 71.4% among adult birds, while young ostriches were infested with Emeria from 20.0% to 44.4%. The largest invasion by helminths and protozoa was observed among black African ostriches in Kharkiv region (41.4%), in Dnepr region it was 33.3%, and in Donetsk it reached 34.1%. Among the livestock of ostriches, there were both mono and mixinvasions. Most often, this was an invasion by *Trichostrongylus* spp. and *Eimeria* spp. in African black ostriches, capillaries and Eimeria in Emu. In Kharkiv region, the invasion of Capillaria by Trichostrongylus in African ostriches and Trichostrongylus in Emu were found when they were kept together. Acute and chronic eimeriosis disease can lead to the death of ostriches at the age of 3-4 months.
Key words: ostriches, helminths, Eimeria, nematodes, eggs, invasion.

Introduction

Ostrich farms bring their owners a steady income in more than a hundred countries around the world. Ostriches are a prolific but not whimsical bird, almost entirely recyclable. They belong to long-livers (life expectancy reaches 70 years), and the mature age lasts up to 30-40 years. In organizing a business, such areas as commercial (obtaining meat, eggs, skin, feathers, fat, etc.), breeding (selling juveniles) and agritourism are possible (Ross & Deeming, 1998; Cloete et al., 2008; Magige et al., 2009; Menon et al., 2014). Farmer breeding of ostriches originated in South Africa about 150 years ago. In 1885, the number of domesticated birds in South Africa did not exceed 80 birds. The birds were bred primarily to meet the demand for ostrich feathers. Today, there are 350 farms in this country, which contain more than 90 thousand ostriches, which produce about 30.000 kg of feathers annually (Boum & Bonine, 2015; Magige & Røskaft, 2017). Over time, ostrich farms began to be created in Australia, Egypt, USA, Argentina. In the 70[s] of the last century, the emphasis gradually shifted to the production of poultry meat and skins. Even 15 years ago, the ostrich population numbered no more than a few thousand, now about three and a half million ostriches are raised on farms in 130 countries. On 12.000 farms in the United States, about 100.000 adults are kept (Bejaei & Chengb 2014). In Mexico, the first ostrich farm was established in 1988 and the sale of breeding stock was profitable until 2008. Until 2016, about 30 farms remained active (Moreno & Rendon, 2020).

In Europe, Italy and Spain are the leaders in the number of these birds. Poland is the most successful example of ostrich breeding in Europe: about 200 farms have been established there in the last decade alone (Horbańczuk et al., 2008). There has been an increase in interest in raising ostriches in China (Feng et al., 2017). The real ostrich boom began in the late 1980[s], when studies of American scientists recommending a healthy lifestyle showed that ostrich meat contains one and a half times less cholesterol and nine times less fat than, for example, beef, not inferior to the latter in taste (Al-Khalifa & Al-Naser, 2014; Horbańczuk et al., 2019).

Ostrich farming is a relatively young poultry industry in Ukraine. Today about 60 farms are engaged in raising ostriches. Despite the fact that the first farms that work in this direction appeared in the early 2000, this business is still considered new and exotic

(Polishchuk et al., 2020). The economic interest in breeding ostriches in Ukraine is due to the opportunity to obtain high-quality products in a short time.

African ostriches were brought to the Ukrainian steppes by Baron Friedrich Edward Falz-Fein as an experiment and took root in the Askania-Nova estate. In the Crimea in 1913 there were about 300 ostrich farms. In recent years, ostrich farms have been created in Kiev, Dnepropetrovsk, Lugansk, Kherson, as well as in Poltava, Sumy and Kharkiv regions. The most popular in farming and specialized poultry farms are African ostriches and Australian ostriches. It is these species of running or, so-called, keel-free birds that have high adaptive qualities and performance levels, and adapt more quickly to technological processes (Strashnyuk & Kiritchenko, 2014). Growing ostriches makes it possible to obtain a variety of products in a short period of time – juveniles, adult birds, hatching and food eggs, slaughter and processing products, down, feathers, etc. (Brand et al., 2018; Cooper, 2000). All ostrich species have high adaptive properties; the survival rate of young and adult birds is at the level of 75-85% (Zhang et al., 2017).

Now conditions have been created for the import of live ostriches from Europe, Africa and Australia. This is a direct threat of the emergence of new, unknown to us infectious and invasive diseases and their spread in safe areas (Springborn et al., 2015). Scientific knowledge about ostrich diseases is incomplete and very fragmented, and specific details on the technical aspects of diagnostic and screening tests are in most cases completely lacking (Verwoerd, 2000; Kritas, 2001). Since ostriches are a species unusual for the territory of Ukraine, they historically live in other climatic conditions, the diseases inherent in these birds in Ukraine are poorly studied. For successful breeding of ostriches, first of all, it is necessary to have sufficient knowledge about their vital activity. Only then is it possible to reduce the risk of their morbidity to a minimum. The key to success in this area is three factors: a complex of veterinary preventive measures, a high-quality feed base, strict adherence to the technological process (Ipek & Sahan, 2004). One of the most common problems in captive breeding of ostriches is the fight against parasitic diseases (Ederli & de Oliveira, 2014; da Silva & Langoni, 2016; Feng et al., 2017). Therefore, the study of the characteristics of parasitic diseases of ostriches in Ukraine is a necessary strategy for maintaining the health of birds and obtaining safe products.

Materials and methods

The aim of our work was to study the main endoparasitic diseases of ostriches in different regions of Ukraine. The experiments were carried out in the laboratory of veterinary sanitation and parasitology of the National Scientific Center "Institute of Experimental and Clinical Veterinary Medicine" (Kharkiv). During 2016-2020, monitoring of invasive diseases of ostriches was carried out on farms for their cultivation in various regions of Ukraine (Donetsk, Kharkiv, Dniprovsk regions). The objects of research were ostriches of different age groups. A clinical examination of black African ostriches (Struthio camelus Linnaeus, 1758), Australian common Emu (Dromaius novaehollandiae Latham, 1790) and rhea (Rhea americana Linnaeus, 1758) was carried out according to existing methods (Yüksek et al., 2002; Buergelt, 2020). Helminoproscopic studies of fecal samples from ostriches of different age groups were carried out using the method of direct smear and concentration (flotation and sedimentation) (Tomza-Marciniak et al., 2014; Byrnea et al., 2018; Ola-Fadunsin et al., 2019).

The extent of bird invasion was determined by the formula:

$$EI = x/y \times 100$$

where: EI – extent invasion, x– the number of animals that have identified eggs or larvae of helminths, y – total number of animals examined, 100 – percentage conversion factor.

Parasitological autopsies of ostriches were carried out according to Wang et al. (2017).

Results

During a clinical examination of adult African ostriches, some observed depression, inactivity, decreased appetite, growth retardation, weight loss, dysfunction of the gastrointestinal tract. Conducted coproovoscopic studies were identified eggs of nematodes and oocysts of the *Eimeria* spp. (Table 1).

Consequently, the adult population of ostriches in specialized and private farms, in eco-zoos is infested with nematodes and protozoa with an extensiveness of invasion from 38.1% to 71.4%. Along with this, young ostriches are infested with Eimeria from 18.2.0% to 44.4%. The greatest infection with helminths and protozoa is observed among black African ostriches in the Kharkiv region – 41.2%, in the Dnepr region it was the least – 33.3%, and in the Donetsk region it reached 34.1%. Parasite infestation in ostriches is most often manifested by general depression, inactivity, decreased appetite, growth and development retardation, and gastrointestinal upset.

Taking into account the data presented by other researchers (Ederli & de Oliveira, 2014), we differentiated helminth eggs isolated from ostriches from different regions of Ukraine (Table 2).

We made a parasitological dissection of two corpses of 3 and 4-month ostriches. The first ostrich cub died at the age of 3 months in a farm in the Kharkiv region in September 2016 with signs of a disorder of the gastrointestinal tract, with suspicion of the presence of a foreign body in the intestine. During dissection revealed: fibrinous layers on the liver, discoloration of its individual areas; hyperemia and edema of the intestinal mucosa, liquid contents of the intestine; thickening of the walls of the cecum with hemorrhages on the mucous membrane. The contents of the intestines are bloody with an unpleasant odor; microscopic examination of smears of prints and flotation examination of the contents of the cecum revealed oocysts of Eimeria from 85 to 125 pieces in the field of view of the microscope. Oocysts of Imperia are also found in the contents of the rectum. There were no foreign bodies in the stomach and intestines. We have been diagnosed with acute edgy – eimeriosis.

Table 1. Extensiveness of invasion among ostriches in Ukraine

Species	Bird age	Number of samples	Number of positive samples	Extent invasion, %	Parasite species
Dniprovsk (Dnepr) region					
Black African ostrich (*Struthio camelus*)	> 3 years	21	8	38.1	*Nematodae* spp. *Eimeria* spp.
	2 months	6	–	–	–
	4 months.	9	4	44.4	*Eimeria* spp.
	9 months	12	4	33.3	*Eimeria* spp.
Summary		48	16	33.3	–
Australian common Emu (*Dromaius novaehollandiae*)	> 3 years	5	2	40.0	*Nematodae* spp. *Eimeria* spp.
Nandu (*Rhea americana*)	> 3 years	2	–	–	–
Total		55	18	32.7	–
Donetsk region					
Black African ostrich (*Struthio camelus*)	> 3 years	30	12	40.0	*Nematodae* spp. *Eimeria* spp.
	3 months	11	2	18.2	*Eimeria* spp.
Summary		41	14	34.1	–
Australian common Emu (*Dromaius novaehollandiae*)	> 3 years	8	1	12.5	*Nematodae* spp.
	3 months	5	–	–	–
Summary		13	1	7.7	–
Total		54	15	27.8	–
Kharkov region					
Black African ostrich (*Struthio camelus*)	> 3 years	7	5	71.4	*Nematodae* spp.
	3 months	10	2	20.0	*Eimeria* spp.
Summary		17	7	41.2	–
Australian common Emu (*Dromaius novaehollandiae*)	> 3 years	9	2	22.2	*Nematodae* spp. *Eimeria* spp.
	9 months	9	2	22.2	*Eimeria* spp.
Summary		18	4	22.2	–
Nandu (*Rhea americana*)	> 4 years	5	1	20.0	*Nematodae* spp.
	3 months	10	4	40.0	*Eimeria* spp.
Summary		15	5	33.3	–
Total		50	16	32.0	–

Table 2. Ostrich endoparasites fauna in Ukraine

Species	Number of positive samples	Parasite species
Dnepr region		
Black African ostrich (*Struthio camelus*)	3	*Capillaria* spp.
	2	*Libyostrongylus douglassii*
	1	*Libyostrongylus douglassii, Eimeria* spp.
	8	*Eimeria* spp.
Australian common Emu (*Dromaius novaehollandiae*)	1	*Capillaria* spp. *Eimeria* spp.
	1	*Libyostrongylus douglassii*
Donetsk region		
Black African ostrich (*Struthio camelus*)	2	*Capillaria* spp.
	8	*Libyostrongylus douglassii*
	2	*Libyostrongylus douglassii, Eimeria* spp.
	2	*Eimeria* spp.
Australian common Emu (*Dromaius novaehollandiae*)	1	*Capillaria* spp., *Eimeria* spp.
Kharkiv region		
Black African ostrich (*Struthio camelus*)	1	*Capillaria* spp.
	3	*Libyostrongylus douglassii*
	1	*Capillaria* spp., *Libyostrongylus douglassii*
	2	*Eimeria* spp.
Australian common Emu (*Dromaius novaehollandiae*)	1	*Libyostrongylus douglassii*
	1	*Capillaria* spp., *Eimeria* spp.
	2	*Eimeria* spp.
Nandu (*Rhea americana*)	1	*Capillaria* spp.
	4	*Eimeria* spp.

In second case, the ostrich died at the age of 4 months at the zoo in 2017. The chick was ill for a week, refused food, he was prescribed antibiotics. During the autopsy of the corpse found: enlargement of the liver, change of color of its individual areas, blood filling of parenchima, stomach half-empty, covered with mucus, walls of blind intestines thickened, in the lumen available layers of fibrin. The large intestine is inflamed with hemorrhage, the contents with a slight touch of blood. In microscopic examination of the contents of the blind intestines and large intestines revealed oocysts of Eimeria from 65 to 85 pieces in the field of view of the microscope, (the final diagnosis – chronic eimeriosis). So, acute and chronic eimeriosis can lead to the death of young animals at the age of 3-4 months. This, in turn, leads to significant economic losses.

We have proved that both mono (27.0%) and mixed (4.4%) ostriches are found among the invazition. African black ostriches are most common infestation by Trichostrongylus and Eimeria, and Dromaius – Capiyaria and Eimeria. It should be noted that in the Kharkiv region, Trichostrongylus invaction was found in African ostriches and Dromaius, which were kept in the same enclosure. Ostriches were infested with Eimeria with an invasion rate of 25.0%.

Discussion

The problem of parasitic diseases of agricultural and domestic animals remains relevant today (Paliy et al., 2018a; 2018b; 2018c; 2019), despite the introduction of new high-performance anthelminths (Lloyd et al., 2000; Lambertz et al., 2019; Preston et al., 2019) and disinfectants (Paliy et al., 2015; 2016; 2020a; Stegniy et al., 2019; Bondarchuk et al., 2019).

Most recently, the results of advanced studies of ostrich parasites (Struthio camelus), mainly from European countries where commercial ostrich farming is gaining momentum (Cooper, 2005) have been published. Parasitological studies are important for the conservation of livestock, as they allow us to assess the risk of transmission of pathogens to ostriches born in captivity from imported wild populations and vice versa (Rafael et al., 2013). The results we received are different from the previous results of 2010. At that time, adult African ostriches from the Donetsk region farm were found to be 100% infected with nematodes of two types of the Strongylata contract. Ostriches 2-3 months of age were 10% invasive, and Emu ostriches were invasive (Babenko et al., 2010).

Infection with nematodes of African ostriches today is 34.1% in the Donetsk region, 6.3% of ostriches affected by Capilaria, 27.8% – Tihostrengylus one species *Libyososgytronlus douglassii*. In addition, among the adult livestock there was invasive Eimeria, which was 2.1%. The infestation of the Eimeria among ostriches reaches 29.6%, which is 2.9 times higher than before. The results obtained in the Dnepr region are also different from those of other researchers (Marshalkina et al., 2013). At that time, the invasiveness of ostriches with Ascarids, Capyllaria and Ttrihostrengylus with EI from 6% to 60% was recorded. According to our results, the invasiveness of ostriches of all species was 32.7%, and the most invasive adult African ostriches by nematodes is 38.1% (14.2% – capillaries, 19.0% – *Libyostrongylus douglassii*, 5.2% – *Libyostrongylus douglassii*, *Eimeria* spp., emu ostriches – 40.0% (20.0% – capillaries, 20% – *Libyostrongylus douglassii*). The infestation of Ascaridia ostriches was not detected, which indicates that the parasitofauna of ostriches in Ukraine is changing and needs more research. Other researchers note a low level of damage to ostriches by nematodes (Cooper, 2005). There are mixed infestations in the zoo bird (Papini et al., 2012).

Libyostrongylus douglassii nematodes of the genus *Libyostrongylus* – hematophagi-parasites that find themselves under the membrane of the forearms of the ostrich: they are common and can cause 50% of the death of young, and sometimes death of adults (Nemejc & Lukesova, 2012). This species has been found in ostriches from Africa, Europe, the Americas and Oceania (de Souza et al., 2019), although the natural range of ostriches is Africa (Barton & Seward, 1993). In our studies among the invasive population of African ostriches EI reaches 45.9%, in it – 20.0%, and in the nandu of this pathogen we did not show. Other researchers report the invasiveness of ostriches (Kritas, 2001; Rafael et al., 2013), and in our results we note the presence of these pathogens in all species of ostriches in three regions of Ukraine. Infestation is common in many countries of the world, where ostriches are grown (Khatri & Maharjan, 2018), but it varies from 0.6 to 60%, and according to our research it is 15.3% among adult birds, and 26.5% among young people. The disease of acute and chronic eimeriosis leads to the death of ostrich at the age of 3-4 months.

The presence of helminths we have identified in ostriches is confirmed by other researchers (Ponce Gordo et al., 2002; Ederli & de Oliveira, 2015; Gallo et al., 2020). Analysis of the invasiveness of ostriches, showed that gradually changes parasstophauna pathogens helminths. It differs from the parasitophauna that is inherent in ostriches in their historical homeland and in Europe (Sotiraki et al., 2001). Most foreign studies are devoted to the study of nematodes from the genus *Libyostrongylus*, and in our case we need to study more representatives of the genus *Capillaria*, the invasive of which in our conditions reaches 27.8%. The infestation of juveniles of all kinds is also a pressing problem of modern times. She grew many times, and the appearance of infestation among adult birds indicates that the pathogen remained in the body of birds, which have already grown in the farms of Ukraine. This means that the quarantine measures that are carried out in farms when importing poultry – substandard. A great deal of attention should be paid to the set of veterinary and sanitary measures, which are mandatory in the breeding and cultivation of farm animals and poultry (Zavgorodniy et al., 2013; Paliy et al., 2020b).

Conclusions

Adult ostriches (over 3 years old) in specialized and farms, in eco-zoos of Kharkiv, Donetsk and Dnepr regions of Ukraine are invasive nematodes and protozoa with the extensiveity of invasion from 38.1% to 71.4% among adult birds. Among ostriches of all species aged 3 to 9 months, the infestation of the inmates ranges from 18.2% to 44.4%. Among black African ostriches in Kharkiv region, inhibition of helminths and protozoa is 41.2%, in Dnepr it is the smallest – 33.3%, and in Donetsk it is 34.1%.

Among the number of ostriches there are both mono (27.0%) and mixinazia (4.4%). African black ostriches are more often infected with Trihostrengylus and Eimeria, Dromaius – Capylaria and Eimeria.

Among the livestock of ostriches, there are both mono (27.0%) and mixinvasions (4.4%). Most often, this is the invasived of Trichostrongylus and Eimeria in African black ostriches, Capilaria and Eimeria in Dromaius. In rhea, mono invasived of Capillaria was found in adult birds. In the Kharkiv region, an invasivtd of Capillaria with Trichostrongylus in African ostriches and Trichostrongylus in Dromaius, which were kept in the same enclosure. The disease of acute and chronic eimeriosis can lead to the death of juveniles at the age of 3-4 months. To prevent the infected of ostriches, during the importation of a new batch of poultry, quarantine must be at least four weeks. It is mandatory to conduct parasitic studies and a set of veterinary and sanitary measures.

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