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Seasonal and Age Dynamics of Passalurosis Invasion of Rabbits and Pathological and Histological Changes in this Nematodosis

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Abstract. The most common nematode in rabbits is passalurosis, and climate change in Ukraine in recent decades has altered the epizootic manifestation of this parasitosis, which predetermines the relevance of this study. Therefore, the purpose of this paper was to establish the epizootic situation regarding the passalurosis invasion and to investigate the pathological and histological changes in both the large and small intestines of rabbits with a high degree of damage by *Passalurus ambiguus*. The study used the McMaster method, the improved method of incomplete helminthological dissection according to K.I. Scriabin Private households in the Polissia zone of Ukraine were found to be the most vulnerable in terms of passalurosis infestation, where 37.70-41.67% of sick rabbits were registered. In the seasonal aspect, the highest infection of animals was found in winter (invasion extensiveness (IE) was 35.27%), with a peak in January (IE = 35.29%), the lowest – in summer (IE = 25.79%). Rabbits aged 1 to 2 years had the highest incidence of the pathogen *Passalurus ambiguus* (82.76%). It was found that with a high degree of damage (invasion intensiveness (II) – 2446.67 ± 422.11 eggs in 1 g of faeces) rabbits with passalurosis had catarrhal and catarrhal-haemorrhagic inflammation, swelling of the mucous membrane of the intestines with dotted or striped haemorrhages. The destruction of the villi of the mucous membrane of the small, caecum, and colon, crypt cells and infiltration by lymphocytes and monocytes, severe swelling of the submucosal base and muscle membrane, and a state of granular dystrophy of all smooth muscle cells of the muscle membrane were established. The detection of seasonal, age-related, and pathological-histological changes in rabbits with passalurosis will allow controlling the degree of infection of animals and promptly taking effective countermeasures, which predetermines the practical value of this study

Keywords: nematodosis of rabbits, *Passalurus ambiguu*s, passalurosis, invasion extensiveness and intensiveness, histological changes

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INTRODUCTION

Rabbit breeding in Ukraine is a major area in the development of meat breeding. Parasitosis is a restraining factor in the development of the industry. In the body of an animal of this species, several types of parasites can be localized, which form a parasitocenosis, and determine the relevance of this study.

One of the most common nematodes in the parasitocenosis of rabbits is passalurosis, which is caused by the pathogen *Passalurus ambiguus Rudolphi, 1819* of the *Oxyuridae* family (Sheng *et al*., 2015; Sultan *et al*., 2015). Helminths parasitize in the caecum and large intestine of animals and lead to various digestive disorders, weight loss, and with a high degree of exposure even to death (Pilarczyk *et al*., 2008; Abdel-Gaber *et al*., 2019).

According to N.M. Hussein *et al.* (2022), infection of animals with the *Passalurus ambiguus* pathogen in rabbit farms in Egypt reaches 45%, and in Italy – up to 82.3% with the invasion intensiveness from a few eggs of the pathogen to about 200 specimens in 1 g of faeces (Nosal *et al*., 2006). According to scientists, passalurosis of rabbits in Serbia was registered in 17.09% of animals (Ilić *et al*., 2018), in Italy – 12.9% (Sergi *et al*., 2018), in Poland – 21.9% (Kornaś *et al*., 2015), in Iraq – 10% (Athraa, 2014), 32.37% (Marhoon, 2018), 52.1% (Al-Moula, 2005). That is, despite a sufficient number of reports, this disease stays relevant in rabbit farms around the world today.

When studying the age dynamics of invasion in rabbits, it was established that animals of different age groups were invaded differently. In rabbits aged under one year, the invasion intensiveness of *Passalurus ambiguus* was 5.8%, while in adults it increased to 23.3% (Ilić *et al*., 2018). Older animals were more often infected with nematodes. As a result of reinfestation in 180-day-old rabbits, the intensiveness of *P. ambiguus* lesions increased 4.0 times (Prus *et al*., 2021). With the age of the animals, the invasion extensiveness increases and ranges within 26.67-77.33% already in 12 months. The average invasion intensiveness in 4-month-old animals is 1,271 specimens of the pathogen, and in 5-7-month-old animals, it is 2,418 specimens. At the age of one year and older, with an increase in the invasion extensiveness, a simultaneous decrease in its intensiveness was detected (from 875 to 343 specimen in one animal). According to G. Sioutas *et al.* (2021), rabbits at 3-6 months are most prone to passalurous invasion, the invasion extensiveness in which was 60%, and the invasion intensiveness was higher in animals aged 6-12 months. However, according to M. Varga (2014), passalurosis is more dangerous for young than for adult rabbits.

In the seasonal aspect, according to N.M. Soroka and I.A. Berehovets (2011), in Ukraine passalurosis is registered almost throughout the year, but the peak of invasion is observed in the winter-spring period. In addition, I. Elshahawy and A. El-Goniemy (2018) noted that the most animals with passalurosis are registered in summer (38.3%) and winter (33.3%). Its distribution, according to Z.K. Terentyeva *et al.* (2021) is contributed by the unsanitary conditions of keeping rabbits on unchanged bedding or floors. The optimal air temperature for egg development, according to V. Yevstafieva *et al.* (2021, 2022) is +35°C. This coincides with the reports of B. Boag (2001), who emphasizes that the maximum percentage of infected animals was detected in January, and the minimum infection of rabbits was registered already in April.

Pathogenic effect of passalurosis, according to H. Legendre *et al.* (2021), depends on the invasion intensiveness. Upon crawling out of the anus of the female, the pinworms cause severe itching in rabbits and thus disturb the animals. In rabbits, intensive reinvasion by the causative agent of passalurosis continually occurs, due to which mature parasites are simultaneously found in the intestines of animals next to young pinworms. The pinworms are tightly pressed to the intestinal mucosa, located between the intestinal villi and oppose peristalsis; penetrating in numerous instances into the Lieberkühn glands, pinworms cause strong mechanical irritation of the epithelial cells. Research by J. Vadlejch *et al.* (2010) found that the pathogens of *Passalurus ambiguus* are coprophages, although R. Frank *et al.* (2013) sometimes observed haematophagy in pinworms.

According to pathomorphological studies (Voitovska, 2019; Karamushka *et al*., 2022), toxicosis phenomena are observed in the caecum, colon, mesenteric lymph nodes, liver, kidneys, heart muscle, in the lungs – signs of enterotoxemia, and in places of localization (caecum and colon intestines) areas of necrosis are formed. Exhaustion is noted in rabbits that died from passalurosis. Mesenteric lymph nodes are juicy, swollen, enlarged 2-3 times. Liquid contents in the large intestine. The mucous membrane of the appendix of the caecum is swollen, often with speckled or striped haemorrhages, easily peels off and separates from the muscle layer of the intestinal wall, traumatic injuries of varying intensity on the vulva and anus. In the chronic course of passalurosis, S.M. Mykhailiutenko *et al.* (2019) established pathomorphological changes in parenchymal organs (lymphohistiocytic interstitial hepatitis and fatty and granular dystrophy of hepatocytes were noted in the liver; necrotic, lipoid, and protein nephrosis, serous extracapillary glomerulonephritis, diffuse lymphohistiocytic interstitial nephritis in the kidneys; lymph node hyperplasia in the spleen). At a high invasion intensiveness by pinworms, the death of rabbits due to peritonitis and haemorrhagic colitis is noted.

The climate in Ukraine has changed a lot in recent decades, which has led to a change in the epizootic manifestation of parasitosis. With the change of climate in the country, the epizootic situation regarding this nematode of rabbits was not studied at all in the entire territory of Ukraine, with only individual regions described. Therefore, *the purpose of this study* was to

establish the epizootic situation regarding passalurosis in Ukraine and to investigate the pathological and histological changes in the intestines of rabbits with a high level of invasion intensiveness.

MATERIALS AND METHODS

The spread of passalurosis infestation was investigated through clinical observation and coproscopic studies of 1,209 domestic rabbits (*Oryctolagus cuniculus*) aged from birth to 4 years in large and small private households from different regions of Ukraine: Volyn, Dnipropetrovsk, Zhytomyr, Zaporizhzhia, Ivano-Frankivsk, Kirovohrad, Lviv, Odesa, Poltava, Kharkiv, Kherson, Khmelnytskyi, Cherkasy. The age and seasonal dynamics of passalurosis were studied in rabbits in the territories of Dnipropetrovsk and Zaporizhzhia regions during 2014-2020. The study was conducted in the scientific laboratories of the Department of Parasitology and Veterinary Expertise of the Faculty of Veterinary Medicine of the Dnipro State Agrarian and Economic University. *Passalurus ambiguus* eggs were identified based on their size and morphological characteristics using the atlas of differential diagnosis of helminthiasis by I.S. Dakhno *et al.* (2001). To determine the level of infection of rabbits with pathogens of *Passalurus ambiguus*, faecal samples were examined using McMaster slide (Cringoli *et al.*, 2004). Therewith, 2 g of faeces were placed in a glass container, mixed with 28 ml of flotation solution (preferably ammonium nitrate), thoroughly mixed and filtered through a strainer. The filtered mixture was resuspended with a pipette, introduced into the counting chamber and left for flotation for 2-3 minutes. Under a microscope, all helminth eggs in the specified fields of two chambers were counted, multiplied by 50 and the number of eggs in 1 g of faeces was obtained.

Autopsies and examination of carcasses of slaughtered rabbits were performed using the improved method of incomplete helminthological dissection according to K.I. Skryabin in the generally accepted sequence (Skryabin, 1928). For histological examination, small pieces, no more than 2 cm thick, of different sections of the intestine were taken. The sampled biological material was fixed in 10% neutral formalin solution. The obtained material was dehydrated in ethanol of increasing strength, embedded in paraffin according to generally accepted methods. Sections were made on a slide microtome (up to 5 μm thick) and stained with Karatsi's haematoxylin and eosin. Microscopy of the obtained histopreparations was performed under an MC 100 LED microscope, and photomicrography was performed through the NDPL-2 photo nozzle (2x) with a Canon DS12671 camera. Histological preparations were examined under a microscope at magnifications: ×100, 200, 400.

Statistical processing of experimental results to determine biometric indicators (arithmetic mean values (M) and their errors (m)) was calculated using the Microsoft Excel-16 program.

When working with animals, the provisions of Article 26 of the Law of Ukraine No. 3447-VI dated 10/16/2012 "On the Protection of Animals from Cruelty" (Law of Ukraine No. 3447-VI), "General Ethical Principles of Animal Experiments", approved on The First National Congress on Bioethics (Reznikov, 2003), the requirements of the European Convention "On the Protection of Vertebrate Animals Used for Research and Other Scientific Purposes" (European convention, 1986), the Declaration "On the Humane Treatment of Animals" (Universal Declaration, 2007).

RESULTS AND DISCUSSION

The conditions of natural and climatic zones are of leading importance in the spread of parasitosis among rabbits. The territory of the flat part of Ukraine comprises three geographical zones: Polyssia, Forest-Steppe, and Steppe, each of which has climatic differences. To establish the epizootic situation regarding rabbit passalurosis, 1,209 animals from 13 regions of Ukraine, located in different natural and climatic zones, were investigated. Infestation of rabbits with passalurosis in different climatic zones is presented in Table 1.

***Table 1**. Invasion of rabbits with Passalurus ambiguus in households of Ukraine, depending on the natural and climatic zone (own data; M ± m, n = 1209)*

Natural and climatic zones	Infection rates	2019	2020
Polissia(p)	IE, %	41.67	37.70
	II, eggs/g	161.67 ± 27.42	162.30 ± 28.84
Forest-Steppe(l)	IE, %	26.92	26.06
	II, eggs/g	116.03 ± 19.20	105.45 ± 17.58
Steppe(s)	IE, %	39.49	37.19
	II, eggs/g	184.37 ± 17.41[ll]	178.24 ± 15.16[ll]
On average	IE, %	36.27	34.12
	II, eggs/g	163.20 ± 12.40	156.20 ± 11.04

***Note:** ll – significant (p<0.01) difference with the specified group of this year*
***Source:** compiled by the authors*

During 2019-2020, the highest number of passalurosis patients (41.67% and 37.70%) were registered in rabbits of personal subsidiary farms in the Polissia zone of Ukraine, simultaneously with an elevated level of invasion intensity (161.67 ± 27.42 and 162.30 ± 28.84 eggs per 1 g of faeces, respectively). This zone includes the surveyed Volyn, Zhytomyr, Ivano-Frankivsk, and Lviv regions. This zone occupies the northern part of Ukraine. The climate of Polissia is continental, with mild winters and humid and warm summers. The average air temperature in July is +17 to +19°C, the average air temperature in January drops to -4.5 – -7.8°C. The average annual precipitation is 550-650 mm (Vrublevska *et al.*, 2012). According to the authors, the climate of Polissia is the most favourable for the development of Passalurus ambiguus from the three climatic zones of Ukraine.

It has been established that passalurosis is a widespread nematodosis of rabbits, which was registered in households in all regions of Ukraine during 2019-2020. IE was, respectively, 36.27% and 34.12% (on average 35.20%). The number of parasites in the external environment, as well as changes in the physiological state of the body and the functioning of the immune system, depend on the season (Duda *et al.*, 2019; Duda *et al.*, 2020). During 2014-2020, in the conditions of farms of the Zaporizhzhia and Dnipropetrovsk regions, during coproovoscopic studies, seasonal patterns of infection of rabbits with *Passalurus ambiguus* were revealed (Table 2).

***Table 2**. Seasonal dynamics of passalurosis rabbit infestation indicators (M ± m, n = 928)*

Infection rates	Seasons			
	Winter	Spring	Summer	Autumn
IE, %	35.27	34.50	25.79	31.27
II, eggs/g	713.69 ± 85.00	207.86 ± 39.64	78.73 ± 8.49	200.32 ± 42.14

***Source:** compiled by the authors*

According to the results presented in Table 2, it was found that in the summer period of the year, the lowest IE was found in rabbits with passalurosis (25.79%), the highest – in the winter period (35.27%). Therewith, the minimum value of the invasion intensiveness was also established in summer (78.73 ± 8.49 eggs in 1 g of faeces), the maximum – in winter (713.69 ± 85.00 eggs/g). Indicators of infestation by the causative agent of passalurosis of rabbits in spring and autumn were recorded at the same level, namely IE – 34.50% and 31.27%, II – 207.86 ± 39.64 eggs/g and 200.32 ± 42.14 eggs/g, respectively. The dynamics of the monthly infection of rabbits with the causative agent of passalurosis was established (Fig. 1). The highest indicator of invasion extensiveness was found in January and February (35.29% and 35.11%, respectively). With the onset of spring (in May), the IE decreased to 32.91%, and in the summer, the IE was the lowest (June) and amounted to 21.43%. In autumn, the extent of passalurosis infestation in rabbits increased, reaching 32.67% in November.

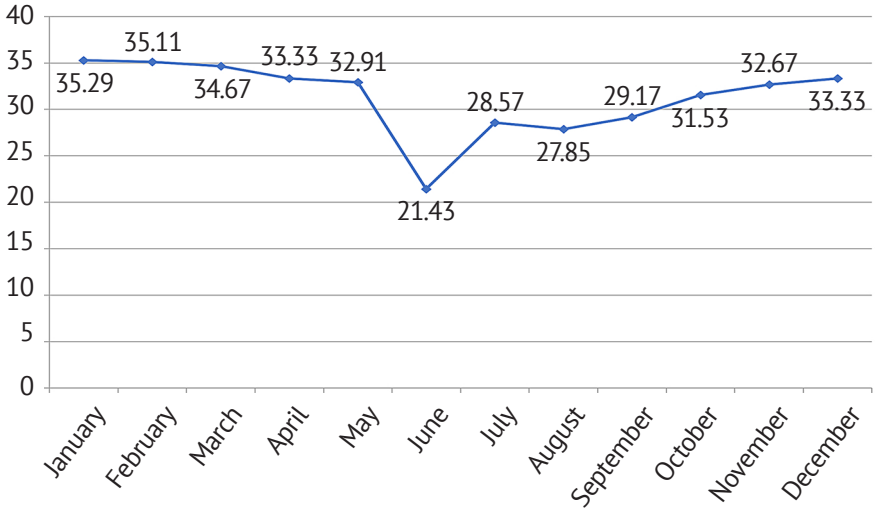

***Figure 1**. Dynamics of the invasion extensiveness of passalurosis in rabbits by month*
***Source:** compiled by the authors*

Similarly, depending on the season, the indicator of the invasion intensiveness (II) of passalurosis changed (Fig. 2). The highest II was observed in January and February (344.12 ± 69.82 and 346.81 ± 71.15 eggs/g, respectively), and the lowest – in June (44.29 ± 11.45 eggs/g).

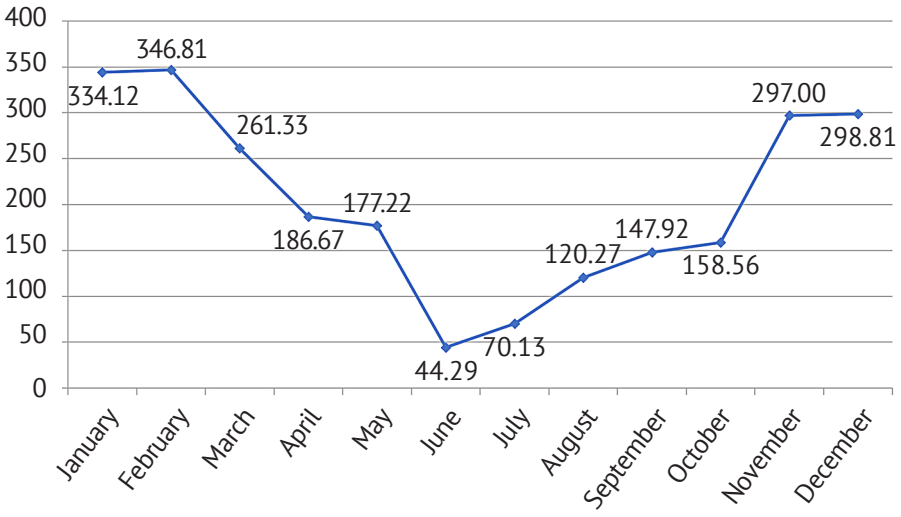

***Figure 2**. Dynamics of the intensity of passalurosis infestation in rabbits by month*
***Source:** compiled by the authors*

According to the data obtained in large and small rabbit farms of Ukraine, the highest rate (35.29%) of infection of rabbits with passalurosis was noted in January. In summer (June) this rate is the lowest and was 21.43%, i.e., the peak of passalurosis infestation in rabbits observed in winter. When investigating the age dynamics of passalurosis infestation in rabbits, it was established that animals of different age groups were invaded differently (Table 3).

***Table 3**. Age dynamics of passalurosis rabbit infestation indicators (M ± m, n = 928)*

Infection rates	Age groups							
	1-2 months	2-3 months	3-4 months	4-5 months	5-6 months	6-9 months	9-12 months	1-2 years
IE, %	0	23.53	44.44	50.00	56.67	77.78	81.48	82.76
II, eggs/g	0	41.17 ± 17.27	133.33 ± 60.09	144.44 ± 42.95	376.67 ± 96.45	716.67 ± 110.33	533.33 ± 89.47	479.31 ± 91.96

***Source:** compiled by the authors*

The data presented in Table 3 indicates that no passalurosis infestation was detected among the rabbits at the age of 1-2 months. From the age of 2-3 months, the invasion extensiveness of pasalurosis increased and in animals aged 1-2 years it was registered in 82.76% of rabbits. The invasion intensiveness also increased in animals aged 6-9 months amounted to 716.67 ± 110.33 eggs/g. In rabbits older than 9 months, the invasion intensiveness of passalurosis decreased and in animals aged 1-2 years it was 479.31 ± 91.96 eggs in 1 g of faeces. The pathogenic effect of *Passalurus ambiguus* depends on the invasion intensiveness (Duda *et al.*, 2019; Shevchik *et al.*, 2021). As a result of helminthocoproovoscopic studies, it was established that rabbits suffering from passalurosis had different levels of invasion intensiveness (II): low level (II = 276.47 ± 43.33 eggs in 1 g of faeces), medium level (II = 1293.75 ± 275, 80 eggs in 1 g of faeces) and high level (II = 2446.67 ± 422.11 eggs in 1 g of faeces) (Fig. 3).

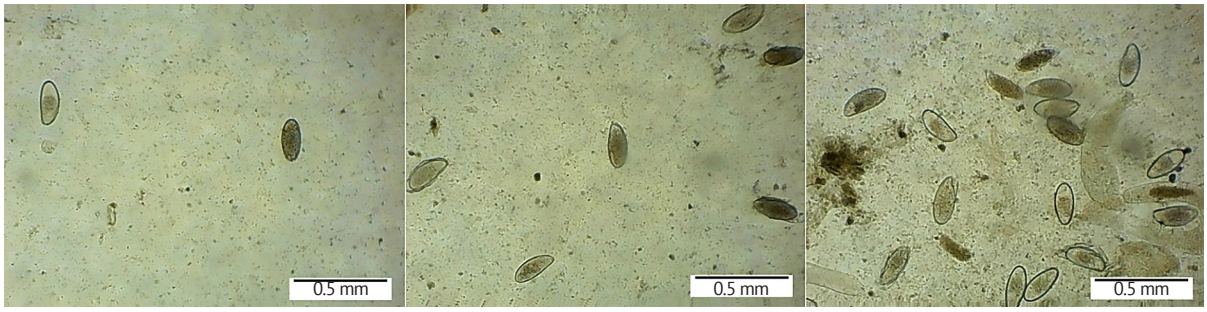

***Figure 3**. Faecal samples of rabbits with different levels of invasion intensiveness*
***Source:** photographed by the authors*

It was found that with a high degree of damage to rabbits by passalurosis, catarrhal and catarrhal-haemorrhagic inflammation was observed in the mucous membrane of the small intestine, the mucous membrane of the caecum was swollen, with dotted or striped haemorrhages (Fig. 4).

***Figure 4**. Small and large intestine of a rabbit affected by Passalurus ambiguus*
***Source:** photographed by the authors*

Upon conducting histological studies in the small intestine, distinct microscopic changes were established. Strong destruction of villi, disruption of the integrity of crypt cells and infiltration by lymphocytes and monocytes were found in the mucous membrane. The submucosa base and muscle membrane are very swollen. All cells of the muscle sheath were in a state of granular dystrophy (Figs. 5; 6). No microscopic changes were detected in the serous membrane.

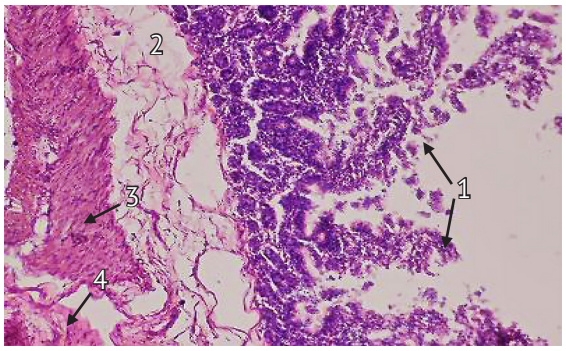

***Figure 5**. An empty stomach of a rabbit with passalurosis: 1 – destruction of villi; 2 – swelling of the submucosal base; 3 – granular dystrophy of muscle sheath cells; 4 – swelling of the muscle layer*
***Note:** Karatsi's haematoxylin and eosin, x100*
***Source:** photographed by the authors*

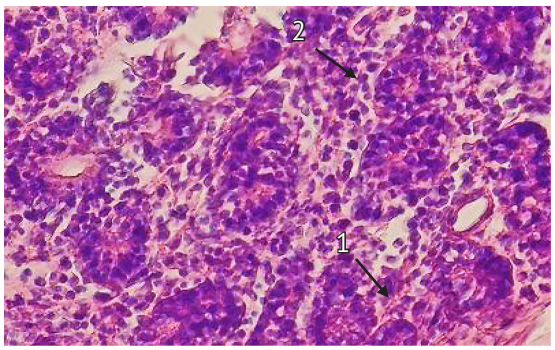

***Figure 6**. Fasting intestine of a rabbit with passalurosis: 1 – destruction of crypt cells; 2 – infiltration of the mucous membrane by lymphocytes and monocytes*
***Note:** Karatsi's haematoxylin and eosin, x400*
***Source:** photographed by the authors*

A large amount of cellular detritus was found in the lumen of the caecum and colon of rabbits with passalurosis. Some of the crypts are destroyed. Relatively large granuloma-like clusters of lymphocytes and monocytes were found on the tops of individual folds of the mucous membrane. The mucous membrane is infiltrated by a considerable number of lymphocytes and monocytes. Oedema was found in the submucosa base (Figs. 7; 8), and in the muscle membrane – oedema, granular and hydropic dystrophy of smooth muscle cells. Some of the dystrophically changed cells were destroyed.

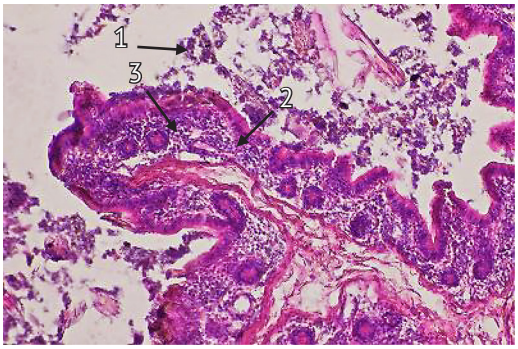

***Figure 7**. Caecum of rabbit with passalurosis: 1 – cellular detritus in the lumen; 2 – destruction of the crypt; 3 – infiltration of the mucous membrane by lymphocytes and monocytes; 4 – swelling of the submucosal base*
***Note:** Karatsi's haematoxylin and eosin, x100*
***Source:** photographed by the authors*

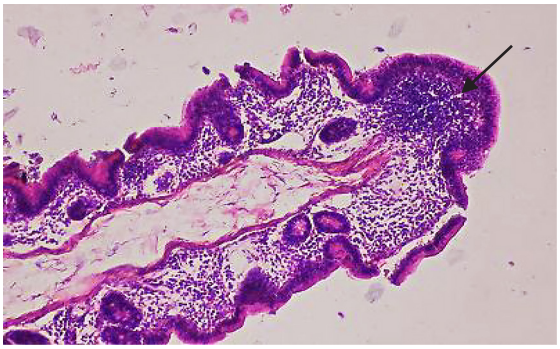

***Figure 8**. Caecum of a rabbit with passalurosis: a granuloma-like accumulation of lymphocytes and monocytes at the top of the fold of the mucous membrane (pointed by an arrow)*
***Note:** Karatsi's haematoxylin and eosin, x200*
***Source:** photographed by the authors*

Therefore, pathogens of *Passalurus ambiguus*, with a high degree of damage to the intestines of rabbits, led to the emergence of a large amount of cellular detritus in the lumen of the caecum and colon of rabbits, destruction of crypt cells, infiltration of the mucous membrane by lymphocytes and monocytes, and oedema in the submucosa and muscle sheath.

Passalurus ambiguus infestation is one of the most common nematode diseases in large and small rabbit farms of Ukraine, and according to the data obtained, the infestation of rabbits by the causative agent *Passalurus ambiguus* was 35.20%. Comparable results were obtained by G. Sioutas *et al.* (2021), who established that the level of infestation of rabbits with the pathogen *Passalurus ambiguus* in rabbit farms in Greece reaches 31% and I.A. Marhoon *et al.* (2018) found that rabbits were affected by this pathogen in Al-Diwaniya province, Iraq – 32.37%. According to V. Yevstafieva *et al.* (2021), in the conditions of one-person farms of the Poltava region, passalurosis was found in an average of 82.09%, and according to the results of O.S. Klymenko (2015) – in 21.26% of rabbits, while the authors also claim that this is the most common helminthosis of rabbits.

According to the obtained results, it was established that the highest rate of passalurosis in rabbits (35.29%) is in January. In the spring, the invasion extensiveness decreases to 32.91%, and in the summer (June), this rate is the lowest and is 21.43%. That is, the peak of passalurosis invasion in rabbits is observed in the winter period. This coincides with the reports of B. Boag (2001), who indicates that the maximum percentage of infected animals was recorded in January,

and the minimum infection of rabbits was detected already in April. The peak of nematode infestation, according to N.M. Soroka *et al.* (2011), was observed in the winter-spring period.

Upon the investigation of the age dynamics of this invasion in rabbits, it was established that animals of different age groups were invaded differently. Passalurosis infestation was not detected among the rabbits at the age of 1-2 months. From the age of 2-3 months, its invasion extensiveness increased and in animals aged 1-2 years it was registered at 82.76%. The study results coincide with those obtained by G. Sioutas *et al.* (2021), who indicated that rabbits aged 3-6 months are most prone to passalurosis infestation, and the invasion intensiveness was higher in animals aged 6-12 months. At the same time, the invasion intensiveness of passalurosis, according to the present study, was increasing already in animals aged 6-9 months, its decrease was observed later against the background of a gradual increase in the infection rate of *Passalurus ambiguus* rabbits.

The studies investigating the effect of *P. ambiguus* on the body of rabbits are outdated and few. S.M. Mykhailoutenko *et al.* (2019) described pathomorphological changes in rabbits during the chronic course of passalurosis, i.e., with low II; Z.K. Terentyeva *et al.* (2021) described these changes for medium and high II, where the main structural changes were revealed only in the large intestine of rabbits.

According to the obtained data, catarrhal and catarrhal-haemorrhagic inflammation and swelling of the mucous membrane of the intestines with dotted or striped haemorrhages were observed in rabbits with a high degree of damage by passalurosis. J.R. Jenkins (2004) also noted that in the presence of up to 500 pinworms in the intestine there are no changes in the mucous membrane, in the presence of up to 1000 parasites – catarrhal inflammation develops, over 1000 passalurosis specimens – haemorrhagic colitis occurs. These data were confirmed by B. Lord (2012), who noted the death of rabbits from peritonitis and haemorrhagic colitis only at a high invasion intensiveness with pinworms. Similar pathomorphological changes in the intestines are described by Z.K. Terentyeva *et al.* (2021), who indicated serous-catarrhal and catarrhal-necrotic inflammations of the large intestine. Mesenteric lymph nodes are enlarged, hyperaemic, swollen. The mucous membranes of the caecum, rectum, and anus are hyperaemic, swollen, with point haemorrhages.

Therewith, according to the results of histological studies, it was established that the destruction of villi, crypt cells and infiltration by lymphocytes and monocytes, swelling of the submucosal base and muscular membrane, granular or hydropic dystrophy of the cells of the muscular capsule were found in the mucous membrane of the small intestine, caecum, and colon. The obtained data coincide with the scientific research of M.N. Nermean *et al.* (2021), who identified similar pathomorphological changes, namely: *Passalurus ambiguus*, penetrating deep into the follicles, caused hyperplasia in the lymphoid tissue and cells of the follicular epithelium; granulomatous reaction was induced due to cellular damage and accumulation of chronic inflammatory oedema. Comparable results were also obtained by Szkucik *et al.* (2014), for chronic passalurosis, namely destruction of the epithelium of the large intestine, lymphohistiocytic infiltration and oedema of the submucosal base and muscle membrane.

According to M. Varga (2014), the changes in passalurosis of rabbits are associated with the tight pressing of nematodes to the mucous membrane between the intestinal villi, penetration into the Lieberkühn glands and strong mechanical irritation of the epithelial cells, as well as due to the effect on the mucous membrane caused by substances produced *P. ambiguus* (Vadlejch *et al.*, 2010; Duda *et al.*, 2019).

Thus, mechanical and toxic damage to the intestine by passalurosis with a high degree of damage led to catarrhal and catarrhal-haemorrhagic inflammation, swelling of the mucous membrane of the intestines with dotted or striped haemorrhages. In the mucous membrane of the small intestine, caecum, and colon, the destruction of villi, crypt cells and infiltration by lymphocytes and monocytes was detected, the submucosa base and the muscle membrane are strongly swollen, all smooth muscle cells of the muscle membrane are in a state of granular dystrophy.

CONCLUSIONS

Passalurosis ambiguus infestation is one of the most common nematode diseases in rabbit farms of Ukraine, the infestation of rabbits by *Passalurus ambiguus* was 35.20%. Rabbits of private households in the Polissia zone of Ukraine were the most vulnerable in terms of passalurosis infestation, where 37.70-41.67% of sick animals were registered.

In terms of seasons, the highest infection rate for passalurosis of rabbits was detected in the winter (IE = 35.27%), the lowest – in the summer (25.79%). The peak of passalurosis infestation in rabbits was observed in January (35.29%), while in June, the invasion intensiveness is the lowest (21.43%). Passalurosis infestation was not detected among the rabbits at the age of 1-2 months. From the age of 2-3 months, its extensiveness increased. Rabbits aged 1 to 2 years had the highest incidence of pathogens Passalurus ambiguus (82.76%). The invasion intensity of passalurosis also increased and in animals aged 6-9 months was 716.67 ± 110.33 eggs/g. In rabbits older than 9 months, II decreased and in animals aged 1-2 years it was 479.31 ± 91.96 eggs in 1 g of faeces.

Mechanical and toxic damage to the intestine by passalurosis with a high degree of damage (II = 2446.67 ± 422.11 eggs in 1 g of faeces) led to

a complex of pathomorphological changes: catarrhal and catarrhal-haemorrhagic inflammation, swelling of the mucous membrane of the intestines with dotted or streaked haemorrhages. Histological examination revealed the destruction of the villi of the mucous membranes of the small, caecum, and colon and cells of the crypts. In the lumen of the caecum and colon, a large amount of cellular detritus and relatively large granuloma-like accumulations of lymphocytes and monocytes on the tops of single folds of the mucous membrane were found. In the submucous base, a strong oedema was established, and in the muscular shell – oedema, granular and hydropic dystrophy of smooth muscle cells. Some of the dystrophically changed cells were destroyed. In the future, it is planned to investigate the microscopic changes in other organs of rabbits with passalurosis with an elevated level of invasion intensiveness.

REFERENCES

[1] Abdel-Gaber, R., Ataya, F., Fouad, D., Daoud, M., & Alzuhairy, S. (2019). Prevalence, morphological and molecular phylogenetic analyses of the rabbit pinworm, *Passalurus ambiguu*s Rudolphi 1819, in the domestic rabbits *Oryctolagus cuniculus*. *Acta Parasitology*, 64(2), 316-330. doi: 10.2478/s11686-019-00047-7.

[2] Al-Moula, I. (2005). Study of some endo and ecto parasites in domestic rabbits in Mosul. *Iraqi Journal of Veterinary Sciences*, 19, 143-153. doi: 10.33899/ijvs.2005.46707.

[3] Athraa, T.W. (2014). *Study of prevalence of gastrointestinal and blood parasites with some histopathological changes of local rabbits in Baghdad province* (Master Thesis, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq).

[4] Boag, B., Lello, J., Fenton, A., Tompkins, D.M., & Hudson, P.J. (2001). Patterns of parasite aggregation in the wild European rabbit (*Oryctolagus cuniculus*). *International Journal for Parasitology*, 31(13), 1421-1428. doi: 10.1016/s0020-7519(01)00270-3.

[5] Bogach, M.V., Paliy, A.P., Horobei, O.O., Perotska, L.V., Kushnir, V.Y., & Bohach, D.M. (2022). Endoparasites of rabbits (*Oryctolagus cuniculus domesticus*) in Southern Ukraine. *Biosystems Diversity*, 30(2), 173-178. doi: 10.15421/012218.

[6] Cringoli, G., Rinaldi, L., Veneziano, V., Capelli, G., & Scala, A. (2004). The influence of flotation solution, sample dilution and the choice of McMaster slide area (volume) on the reliability of the McMaster technique in estimating the faecal egg counts of gastrointestinal strongyles and Dicrocoelium dendriticum in sheep. *Veterinary Parasitology*, 123(1-2), 121-131. doi: 10.1016/j.vetpar.2004.05.021.

[7] Dakhno, I.S., Berezovskyi, A.V., Galat, V.F., Aranchii, S.V., Yevstafieva, V.O., & Dakhno, G.P. (2001). *Atlas of animal helminths*. Kyiv: Vetinform.

[8] Duda, Y.V., & Prus, M.P. (2019). Indicators of cellular immunity of the blood of rabbits under the influence of the causative agent of passalurosis. *Veterinary Biotechnology*, 35, 35-44. doi: 10.31073/vet_biotech35-05.

[9] Duda, Y.Y., Prus, M.P., Shevchik, R.S., Koreyba, L.V., Mylostyvyi, R.V., & Samoiliuk, V.V. (2020). Seasonal influence on biochemical blood parametersin males of Californian rabbit breed. *Ukrainian Journal of Ecology*, 10(4), 262-268. doi: 10.15421/2020_197.

[10] Elshahawy, I., & El-Goniemy, A. (2018). An epidemiological study on endoparasites of domestic rabbits (*Oryctolagus cuniculus*) in Egypt with special reference to their health impact. *Sains Malaysiana*, 47, 9-18. doi: 10.17576/jsm-2018-4701-02.

[11] European convention for the protection of vertebrate animals used for experimental and other scientific purposes. (1986, March). Retrieved from https://rm.coe.int/168007a67b.

[12] Frank, R., Kuhn, T., Mehlhorn, H., Rueckert, S., Pham, D., & Klimpel, S. (2013). Parasites of wild rabbits (*Oryctolagus cuniculus*) from an urban area in Germany, in relation to worldwide results. *Parasitology Research*, 112, 4255-4266. doi: 10.1007/s00436-013-3617-7.

[13] Hussein, N.M., Rabie, S.A.H., Abuelwafa, W.A., & Eldin, M.M.M. (2022). Morphometry, molecular identification and histopathology of *Passalurus ambiguu*s Rudolphi, 1819 in domestic rabbits (*Oryctolagus cuniculus*) in Qena, Upper Egypt. *Journal of Parasitic Diseases*, 46, 511-525. doi: 10.1007/s12639-022-01477-3.

[14] Ilić, T., Stepanović, P., Nenadović, K., & Dimitrijević, S. (2018). Improving agricultural production of domestic rabbits in Serbia by follow-up study of their parasitic infections. *Iranian Journal of Veterinary Research*, 19(4), 290-297.

[15] Jenkins, J.R. (2004). Gastrointestinal Diseases. *Ferrets, Rabbits, and Rodents*, 161-171. doi: 10.1016/B0-72-169377-6/50018-6.

[16] Karamushka, V., Boychenko, S., Kuchma, T., & Zabarna, O. (2022). Trends in the environmental conditions, climate change and human health in the Southern region of Ukraine. *Sustainability*, 14(9), 56-64. doi: 10.3390/su14095664.

[17] Klymenko, O.S. (2015). Spread of parasitosis of rabbits in private farms of Poltava region. *Bulletin of the Poltava State Agrarian Academy*, 1-2, 109-112. doi: 10.31210/visnyk2015.1-2.23.

[18] Kornaś, S., Kowal, J., Wierzbowska, I., Basiaga, M., Nosal, P., & Niedbała, P. (2015). The Alice – "Follow the White Rabbit" – parasites of farm rabbits based on coproscopy. *Annals of Parasitology*, 61(4), 257-261. doi: 10.17420/ap6104.16.

[19] Law of Ukraine No. 3447-IV "On the Protection of Animals from Cruelty". (2006, February). Retrieved from https://zakon.rada.gov.ua/laws/show/3447-15#Text.
[20] Legendre, H., Goby, J., Le Stum, J., Hoste, H., Cabaret, J., & Gidenne, T. (2021). Organic rabbit farming: Should we be afraid of gastrointestinal parasites? *In 12th World Rabbit Congress*. Retrieved from https://hal.inrae.fr/hal-03645404/document.
[21] Lord, B. (2012). Gastrointestinal disease in rabbits 1. *Clinical Practice*, 34(2), 90-96. doi: 10.1136/inp.e328.
[22] Marhoon, I.A., Mattar, K.T., & Mohammad, F.I. (2018). Parasitic infection in wild rabbits *Oryctolagus Cuniculus*. *Eurasian Journal of Analytical Chemistry*, 13(5), 1306-3057. doi: 10.29333/ejac/95252.
[23] Mykhailiutenko, S.M., Kruchynenko, O.V., Klymenko, O.S., Serdioucov, J.K., Dmytrenko, N.I., & Tkachenko, V.V. (2019). Pathomorphological changes in the large intestine of rabbits parasitised by *Passalurus ambiguus* (*Nematoda, Oxyuridae*). *Regulatory Mechanisms in Biosystems*, 10(1), 69-74. doi: 10.15421/021911.
[24] Mykhailoutenko, S.M., Kruchynenko, O.V., Serdyukov, Y.K., Klymenko, O.S., & Popovych, Y.D. (2019). Pathomorphological changes in parenchymal organs of rabbits during the chronic course of passalurosis. *Scientific Bulletin of S.Z. Gzhitskyi LNUVM and BT*, 21(93), 31-37.
[25] Nermean, M.H., Soheir, A.H.R., Wafaa, A.A., & Mouchira, M.M.E. (2021). Morphological and molecular identification of *Passalurus ambiguus* Rudolphi, 1819 in domestic rabbits (*Oryctolagus Cuniculus*) in Qena Governorate, Upper Egypt. doi: 10.21203/rs.3.rs-1101490/v1.
[26] Nosal, P., Petryszak, A., Nowosad, B., & Sobolewska, M. (2006). Pasozyty przewodu pokarmowego krolikow w badaniach koproskopowych. *Wiadomości Parazytologiczne*, 52(4), 327-330.
[27] Pilarczyk, B., Balicka-Ramisz, A., Ramisz, A., & Ciechanowicz, J. (2008). Wstępne badania nad parazytofauną zajęcy introdukowanych na teren wyspy Chrząszczewskiej, Pomorze Zachodnie. *Wiadomości Parazytololgiczne*, 54, 159-161.
[28] Prus, M.P., & Duda, Y.V. (2021). Pathogens of diseases of the digestive tract of rabbits in the parasitocenosis. *Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies. Series: Veterinary sciences*, 23(102), 93-98. doi: 10.32718/nvlvet10214.
[29] Reznikov, O.G. (2003). General moral principles of animal experimentation. First National Congress on Bioethics. *Endocrinology*, 8(1), 142-145.
[30] Sergi, V., Romeo, G., Serafini, M., Torretta, E., & Macchioni, F. (2018). Endoparasites of the European Hare (*Lepus Europaeus*) (Pallas, 1778) in Central Italy. *Helminthologia*, 55(2), 127-133. doi: 10.2478/helm-2018-0011.
[31] Sheng, L., Cui, P., Fang, S.F., Lin, R.Q., Zou, F.C., & Zhu, X.Q. (2015). Sequence variability in four mitochondrial genesamong rabbit pinworm (*Passalurus ambiguus*) isolates from different localities in China. *Mitochondrial DNA*, 26(4), 501-504. doi: 10.3109/19401736.2013.855898.
[32] Shevchik, R., Duda, Y., Gavrilina, O., & Samoyluk, H. (2021). Impact of *Amaranthus hypochondriacu*s in nutrition for rabbits on meat quality. *Journal of the Hellenic Veterinary Medical Society*, 72(1), 2713-2722. doi: 10.12681/jhvms.26756.
[33] Sioutas, G., Evangelou, K., Vlachavas, A., & Papadopoulos, E. (2021). Deaths due to mixed infections with *Passalurus ambiguu*s, Eimeria spp. and *Cyniclomyces guttulatus* in an industrial rabbit farm in Greece. *Pathogens*, 10(6), article number 756. doi: 10.3390/pathogens10060756.
[34] Skryabin, K.I. (1928). *Method of complete helminthological dissections of vertebrates, including man*. Moscow: MSU Press.
[35] Soroka, N.M., & Berehovets, I.A. (2011). Epizootology, peculiarities of pasalurosis of rabbits in the conditions of private farms. *Scientific Journal of National University of Bioresources and Nature Management of Ukraine*, 167, 108-110.
[36] Sultan, K., Elhawary, N.M., Sorour, S.G., & Sharaf, H.M. (2015). Observations of the rabbit pinworm *Passalurus ambiguus* (Rudolphi, 1819) in domestic rabbits (*Oryctolagus cuniculus)* in Egypt using a scanning electron microscope. *Tropical Biomedicine*, 32, 1-8.
[37] Szkucik, K., Pyz-Łukasik, R., Szczepaniak, K.O., & Paszkiewicz, W. (2014). Occurrence of gastrointestinal parasites in slaughter rabbits. *Parasitology Research*, 113, 59-64. doi: 10.1007/s00436-013-3625-7.
[38] Terentyeva, Z.K., Taiguzin, R.S., Matveev, O.A., Shakhbiyev, K.K., & Kryazhev, A.L. (2021). Diagnostic studies for common invasive and infectious pathologies of rabbits in the Orenburg region. *E3S Web of Conferences*, 282, article number 03020. doi: 10.1051/e3sconf/202128203020.
[39] Universal Declaration on Animal Welfare. (2007, March). Retrieved from https://web.archive.org/web/20090219033045/http://animalsmatter.org/downloads/UDAW_Text_2005.pdf.
[40] Vadlejch, J., Lytvynets, A., Jankovská, I., & Langrová, I. (2010). Peptidases of pinworms *Syphacia muris* and *Passalurus ambiguus*. *Experimental Parasitology*, 126(2), 156-160. doi: 10.1016/j.exppara.2010.04.018.
[41] Varga, M. (2014). Infectious diseases of domestic rabbits. *Textbook of Rabbit Medicine*, 435-471. doi: 10.1016/B978-0-7020-4979-8.00014-5.

[42] Voitovska, Y. (2019). Natural resources usage as a basis for transformation of agricultural production in Ukraine. In *II international conference on global business and law development imperatives*. (pp. 41-46). Kyiv: KNUTE. doi: 10.31617/k.knute.2019-10-10.03.
[43] Vrublevska, O.O., & Katerusha, H.P. (2012). *Climate of Ukraine and applied aspects of its use*. Odesa: ODEKU.
[44] Yevstafieva, V., Khorolskyi, A., & Melnychuk, V. (2021). The effectiveness of the proposed method of culturing eggs of nematodes *Passalurus ambiguus*, parasitic in rabbits. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Veterinary Sciences*, 23(101), 26-30. doi: 10.32718/nvlvet10105.
[45] Yevstafieva, V., Khorolskyi, A., Kravchenko, S., Melnychuk, V., Nikiforova, O., & Reshetylo, O. (2022). Features of the exogenic development of *Passalurus ambiguus* (*Nematoda, Oxyuroidae*) at different temperature regimes. *Biosystems Diversity*, 30(1), 74-79. doi: 10.15421/012207.

Сезонна та вікова динаміка пасалурозної інвазії кролів і патолого-гістологічні зміни за даного нематодозу

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Анотація. Найбільш поширеним нематодозом у кролів є пасалуроз, а зміна клімату в Україні за останні десятиліття призвела до зміни епізоотичного прояву даного паразитозу, що зумовлює актуальність вивчення цієї проблеми. Тому метою роботи було встановити епізоотичну ситуацію щодо пасалурозної інвазії та вивчити патолого-гістологічні зміни як у товстій, так і в тонкій кишках кролів за високого ступеню ураження *Passalurus ambiguus*. В роботі було використано метод МакМастера, удосконалений метод неповного гельмінтологічного розтину за К. І. Скрябіним. Найбільш неблагополучними щодо пасалурозної інвазії були виявлені приватні домогосподарства зони Полісся України, де реєстрували від 37,70 до 41,67 % хворих кролів. У сезонному аспекті найвищу зараженість тварин було встановлено взимку (екстенсивність інвазії (EI) становила 35,27 %), з піком у січні (EI = 35,29 %), найнижчу – влітку (EI = 25,79 %). Кролі віком від 1 до 2 років мали найвищу ураженість збудником *Passalurus ambiguus* (82,76 %). Було з'ясовано, що за високого ступеню ураження (інтенсивність інвазії (II) – 2446,67 ± 422,11 яєць в 1 г фекалій) кролів пасалурісами відмічено катаральне та катарально-гемарагічне запалення, набряклість слизової оболонки кишок з крапковими чи смугастими крововиливами та встановлено руйнування ворсинок слизової оболонки тонкої, сліпої й ободової кишок, клітин крипт і інфільтрацію лімфоцитами й моноцитами, сильний набряк підслизової основи та м'язової оболонки, стан зернистої дистрофії усіх гладких м'язових клітин м'язової оболонки. Виявлення сезонних, вікових та патолого-гістологічних змін у кролів за пасалурозу дозволить контролювати ступінь зараженості тварин та своєчасно вживати ефективні заходи боротьби, що зумовлює практичну цінність цієї роботи

Ключові слова: нематодоз кролів, *Passalurus ambiguus*, пасалуроз, екстенсивність та інтенсивність інвазії, гістологічні зміни