Effectiveness of a modern antiparasitic agent for deworming in domestic animals

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Parasitic diseases continue to account for a significant proportion of overall morbidity in many parts of the world despite improved living conditions and increased awareness of health issues. The creation of innovative veterinary antiparasitic agents is a promising area of modern veterinary pharmacy. The pathogens Dipylidium caninum, Ancylostoma caninum, Toxocara canis, Toxocaris leonina were identified in the study of stray dogs (n=12). Eggs of Dipylidium caninum, Toxocara mystax, and Toxocaris leonina were found during cats’ examination (n=15). Both mono and mixed invasions have been diagnosed in animals. We established that the floor and inventory were contaminated with exogenous forms of helminths at an extent of 100% after keeping animals in the shelter's enclosures. An innovative antiparasitic agent was used to treat animals. One tablet (0.5 g) contains the following active ingredients such as pyrantel pamoate (150±0.5 mg), praziquantel (50±0.5 mg), and auxiliary substances (lactose, microcrystalline cellulose, calcium stearate, sodium chloride, food flavoring “meat”, povidone K 30 and potato starch). We estimated high antiparasitic agents’ extensive efficiency (100%) at mono and mixed invasions in dogs and cats.

Keywords: dogs, cats, helminth eggs, antiparasitic agent, extensiveness and intensity of invasion.

Introduction

In recent years, many countries have experienced dramatic changes in climate and landscape due to urbanization processes, which contributes to a significant change in biodiversity in these regions (Bogach et al., 2020). Since over 75% of human diseases are of zoonotic origin, it is crucial to understand the dynamics of interactions between nature, pets, and humans and conduct more targeted studies of the transmission of zoonotic parasites (Mackenstedt et al., 2015). The emergence of new diseases can be caused by many factors, including climate change, global warming, population mobility, animal movements, globalization of trade, social and cultural factors, innovative agricultural practices, inappropriate or overuse of certain drugs that lead to resistance of pathogens (Yan et al., 2010; Atehmengo & Nnagbo, 2014). Infectious agents can be transmitted by the fecal-oral route, by direct contact through bites or scratches, indirectly different transmissive vectors, and accidentally due to environmental contamination with pathogenic microorganisms, including aerosol of dried animal feces (Fong, 2017). Mammals can be infected with a wide range of gastrointestinal parasites, containing exogenous forms presented in feces and subsequently contaminate soil and water (Nunn et al., 2011). It has also been found that double-winged insects contribute to the spread of helminth eggs in natural foci. There were animal ectoparasites among them (Ibrahim et al., 2018). The increase in the number of stray animals on the streets causes environmental pollution by exogenous forms of helminths, the spread of invasive diseases among domestic animals, in particular helminthiases (Paliy et al., 2019). Free-roaming cat populations pose a significant threat to public health and are the source of many zoonotic diseases, including rabies, toxoplasmosis, plague, and tularemia. Some of these diseases cause serious health problems in humans and even death.
Effectiveness of a modern antiparasitic agent

An innovative antiparasitic agent was used for research. One tablet (0.5 g) contains active ingredients such as pyrantel pamoate (150±0.5 mg), praziquantel (50±0.5 mg), and auxiliary substances (lactose, microcrystalline cellulose, calcium stearate, sodium chloride, food flavoring "meat", povidone K-30 and potato starch). Pyrantel pamoate is effective against nematodes (round helminths). It affects their cholinergic receptors, which leads to irreversible spastic paralysis of the parasites (St George, 2001). Pyrantel pamoate is almost not absorbed by the intestines, and its anthelmintic effect is prolonged due to this property. Nematodes are excrated from animals' bodies, predominantly unchanged with feces (Mackenstedt et al., 1993; Arion et al., 2018).

Praziquantel is active against cestodes (tapeworms). It increases the permeability of membranes for calcium ions, causes an increase in muscle activity, is accompanied by muscle contraction and spastic paralysis, and destroys the outer cover of adult forms of parasites (Tchuem Tchuente et al., 2013; Ghazy et al., 2020). The experiments were conducted in the Laboratory of Veterinary Sanitation and Parasitology of the National Scientific Center "Institute of Experimental and Clinical Veterinary Medicine" (Kharkiv, Ukraine) and based on an animal shelter (Balakleya, Kharkiv region, Ukraine). Dogs (n=12) and cats (n=15) of various breeds and ages were used as experimental animals.

Research scheme:
1) Clinical examination of animals in the shelter, making a preliminary diagnosis, taking fecal samples for laboratory research, constant clinical observation of the physiological state of experimental animals;
2) Microscopic examination of samples with the determination of pathogens of helminthic diseases in the biological material, their identification, the establishment of the extensiveness of invasion in dogs and cats;
3) Administration of the drug (individually), keeping the animals in the shelter, taking fecal samples for laboratory research 5, 10, and 15 days, and one month after the drug's last use. Determination of the extensive efficiency of use of the drug;
4) Daily clinical examination of the state of health of the experimental animals during the experiment's entire period. Laboratory glassware, microscope, refrigerator, Petri dishes, slides and coverslips, reagents for microscopic studies (saturated NaCl solution, glycerin), fecal samples from experimental animals (dogs, cats) were used in the research.

Visual and microscopic methods carried out the studies per the assigned tasks (Taglioretti et al., 2014). Vital diagnostics of helminthiasis were conducted, and the number of helminth eggs was determined. The pathogens were identified by a microscopic method. The intensity of invasion was determined by counting the number of helminth eggs in 1 g of feces. The animals of the experimental groups were provided with appropriate conditions of keeping. Clinical examination of the animals was carried out before, during, and after treatment. The drug was administered to the animals once per os with a small amount of feed individually (Table 1).

Accounting of research results was conducted based on examinations of treated animals and detection of helminth eggs in fecal samples in 5, 10, 15, and 30 days after treatment. The extensiveness of invasion after treatment and the extensibility of the drug were also determined.

The Study of feces was carried out according to the Fueleborn flotation method according to GOST 26283 (ST SEV 2647-80) using a light microscope with a magnification (× 100). The found helminth eggs were examined at magnification (× 400) with...
their subsequent identification. The assessment of the drug’s antiparasitic action was carried out when the clinical signs of the disease disappeared, and there were no exogenous forms of parasites in animal feces (Seyoum et al., 2017).

**Table 1. Dosage of the antiparasitic agent**

| Animals              | Animal body weight, kg | Dosage, tablets |
|----------------------|------------------------|-----------------|
| Dogs, puppies        | up to 2                | 1/4             |
|                      | 2-5                   | 1/2             |
|                      | 6-10                  | 1               |
|                      | 11-20                 | 2               |
| Dogs                 | 21-30                 | 3               |
|                      | 31-40                 | 4               |
|                      | 41-50                 | 5               |
| Kittens              | –                     | 1/4             |
| Cats                 | –                     | 1/2             |

We carried out the investigations of washings from the enclosures where the experimental animals were kept by the flotation method. Samples from feeders, walls, and floors were taken to determine the sanitary level of environmental pollution by exogenous forms of helminths in animal enclosures. Samples of washings were taken with cotton-gauze swabs soaked in sterile saline. The formula determined the extent of invasion:

$$EI = \frac{x}{y} \times 100$$

where: $EI$ – extensiveness of invasion;
$x$ – number of fecal samples where helminth eggs were detected;
$y$ – total number of fecal samples;
100 – conversion factor to percent.

The drug’s extensive efficiency (EE) was calculated by the number of treated animals that were completely free from invasion in a percentage. Experiments with animals were performed according to current bioethical requirements (Festing & Wilkinson, 2007; Kabene & Baadel, 2019).

**Results and discussion**

We established that weight loss, indigestion, and dullness of fur were found in some dogs and cats due to clinical examination. Animals do not gain weight; young animals do not grow well with an adequate feeding diet. We collected fecal samples from all animals for laboratory study (Table 2) and sampled the swabs for research contamination by exogenous helminths from the room where the animals were kept (Table 3).

**Table 2. Determination of the extensiveness and intensity of infestation by helminths (qualitative and quantitative composition) in dogs (n=12) and cats (n=15)**

| Animals | Helminth species     | The extensiveness of invasion, % | The intensity of invasion, the number of helminth eggs in 1 g of feces |
|---------|----------------------|---------------------------------|---------------------------------------------------------------|
| Dogs    | Dipylidium caninum   | 100                             | 13.1±1.0                                                     |
|         | Ancylostoma caninum  | 20                              | 7.5±4.0                                                      |
|         | Toxocara canis       | 50                              | 3.5±1.5                                                      |
|         | Toxocaris leonina    | 10                              | 3.5±2.5                                                      |
|         | Dipylidium caninum   | 66.7                            | 11.5±2.5                                                     |
| Cats    | Toxocara mystax      | 100                             | 3.5±1.5                                                      |
|         | Toxocaris leonina    | 20                              | 2.5±1.5                                                      |

We registered monoinvasion in three dogs, which accounted for 25% of the surveyed animals. We also determined the invasion caused by three helminth species (*Dipylidium caninum*, *Toxocaris leonina*, and *Ancylostoma caninum*) in one dog. Monoinvasion was found in two cats only that accounted for 13.3% of the number of examined animals. Studies have shown that the premises’ dishes and walls where the experimental animals were kept did not contain the helminth eggs. Helminth eggs were not isolated. Simultaneously, the floor and equipment in dog enclosures and cat care before the anthelmintic use were contaminated with eggs of various helminths in 100% of cases. The number of helminth eggs varied from 2.5 to 5.5 in 1 sample. We found that exogenous forms of helminths are contaminated with the floor and trays in the premises for cats with an invasion rate of 20 and 60%, respectively. The average intensity of invasion was 1.5 helminth eggs. After the formation of research groups of animals, an antiparasitic drug was applied (Table 4).

**Table 3. Determination of the extensiveness and intensity of pollution by exogenous forms of helminths in premises for keeping animal**
Parasitic diseases of farm and domestic animals are essential for modern veterinary practice (Epe et al., 2007; Koch & Willesen, 2009). This situation challenges in epidemiology and epizootiology depends on their uncontrolled spread to new ecological niches and territories, which is especially true for changes in various diseases' etiological factors and climatic conditions. Climate change and rising global temperatures threaten to modify the geographical distribution of parasitic diseases, which affects the health of both animals and humans (Patz et al., 2000). The ability of humanity to respond or adapt to new challenges in epidemiology and epizootiology depends on their magnitude and speed of change, as well as the ability to support systems and infrastructure.

Table 4. Therapeutic efficacy of the antiparasitic drug

| Animals | Before treatment | After treatment |
|---------|-----------------|-----------------|
|         | EI, %           | II, average     | 5 days | 10 days | 15 days | 30 days |
|         | EI, %           | II              | EI, %  | EI, %   | EI, %   | EI, %   | EI, %   | EI, %   |
| Dogs (n=12) | 100            | 7.2             | 16.7   | 12.5    | 0       | 0       | 0       | 0       |
| Cats (n=15)  | 100            | 6.8             | 13.3   | 7.5     | 0       | 0       | 0       | 0       |

After the drug was administered, we observed 10% of the animals with drowsiness and lack of appetite. The animals did not go near the food but drank much water during the experiment's first day. We registered discharge of sexually mature forms of helminths with animal feces. However, we did not observe further complications or changes in the clinical condition of the experimental animals. The extent of invasion in dogs decreased by 83.3% after administering anthelmintic drugs, the average intensity of invasion increased by 73.6% to the average intensity of invasion before treatment; the extent of the invasion in cats decreased by 86.7% after the drug administration on the fifth day; the average intensity of invasion increased by 10.0% to the average intensity of invasion before treatment.

An increase in the intensity of invasion after application of the drug was due to a process when sexually mature females of parasites increase the number of secreted eggs caused by uncontrolled contraction of muscles of the uterus under the action of anthelmintic. From 10 days to 30 days of observation in animals' feces, we did not detect helminth eggs, so the tool's extensibility was 100%. We established that the extensive efficiency (EE) of the antiparasitic drug was 100% in the Study on dogs and cats on mono and mixed invasion of helminths while summarizing the results. Simultaneously, we carried out studies of swabs taken from enclosures where experimental animals were kept for the presence of exogenous forms of helminths (Table 5).

Table 5. Extensiveness and intensity of pollution by exogenous forms of helminths in premises for keeping animals

| Animals | Period of observation | Before treatment | After treatment |
|---------|-----------------------|-----------------|-----------------|
|         | EI, %                 | II              | EI, %           | II              | EI, %   | II              |
|         | 5 days                | 10 days         | 15 days         | 30 days         |
| Dogs    | Flor                  | 100             | 2.5±1.5         | 100             | 4.5±1.5 | 0               | 0               |
|         | Inventory             | 100             | 5.5±2.5         | 100             | 7.5±2.5 | 0               | 0               |
| Cats    | Trays                 | 20              | 1.5±0.5         | 100             | 3.5±0.5 | 0               | 0               |
|         | Inventory             | 60              | 1.5±0.5         | 100             | 5.5±0.5 | 0               | 0               |

As can be seen from the data in Table 5, pollution by exogenous forms of helminths in enclosures where animals were kept grows on the fifth day after deworming due to the active release of parasites from the animal body treated by the drug. Exogenous forms of helminths in buildings were not detected after 10-30 days, which indicates the absence of their excretion by experimental animals. Parasitic diseases of farm and domestic animals are essential for modern veterinary practice (Epe et al., 2004; Paliy et al., 2018c). The ubiquitous distribution of animal helminths has been established in various geographic zones of the world (Trotz-Williams & Trees, 2003; Traversa et al., 2010; Paliy et al., 2020b).

Climate change and rising global temperatures threaten to disrupt the physical, biological, and ecological life-support systems on which human and animal health depends, which is especially true for changes in various diseases' etiological factors and their uncontrolled spread to new ecological niches and territories (Blashki et al., 2007; Koch & Willesen, 2009). This situation increases biological risks for both animals and humans (Patz et al., 2000). The ability of humanity to respond or adapt to new challenges in epidemiology and epizootiology depends on their magnitude and speed of change, as well as the ability to
recognize, effectively contain and control biological threats at an early stage and provide appropriate treatment and prevention (Khasnis & Nettlemale, 2005). Timely complex diagnostics of diseases play an important role in control and prevention measures against parasitic invasions (Paliy et al., 2018b; Conboy, 2009). Improvements and new serological, molecular, and imaging disease tests and the development of broad-spectrum chemotherapeutic agents have led to significant reductions in morbidity and mortality caused by parasitic zoonoses (Macpherson, 2005).

There is no convincing alternative to chemical control for parasitic invasions (Shkromada et al., 2019b; Zhang et al., 2019; Paliy et al., 2020d). Many anthelmintics are used, which differ in their spectrum of action, composition, and active substances, to treat animals with parasitic diseases (Venco et al., 2008). Along with this, multiple anthelmintic resistance has been established in A. caninum field isolates that indicates a new problem in treating this disease (Kopp et al., 2007; Jimenez Castro et al., 2019). Repeated treatment with lower pyrantel pamoate concentrations will be more effective than higher concentrations given only once (Mackenstedt et al., 1993). Anthelmintic drug resistance has become a significant concern in veterinary medicine and threatens agricultural incomes and animal welfare (Fanning et al., 2010). The molecular and biochemical basis of this resistance is insufficiently studied. The lack of reliable biological and molecular testing means that we cannot monitor the emergence and distribution of resistance alleles and clinical resistance of helminths (Wolstenholme et al., 2004; Kaplan, 2004).

Disinfection of veterinary control facilities is becoming increasingly crucial despite the high level of provision of specific agents in the fight against various etiology diseases (Stegniy et al., 2019; Paliy et al., 2020c). However, the use of disinfectants in specific conditions requires their additional approval and determination of useful modes of exposure (Paliy et al., 2016; 2018a; Shkromada et al., 2019a). A study and practical application of scientific approaches to use animal parasites' natural enemies is a separate scientific area (Paliy et al., 2018d; 2020a).

Domestic animals' owners should be appropriately informed about zoonotic risks, and veterinarians should organize regular screening and treatment of domestic animals. The establishment of national surveillance programs to determine the incidence and the presence of a specific etiological agent in sick animals is an urgent task today (Lee et al., 2010; White et al., 2017). Wildlife plays a vital role in the epidemiology of parasitic diseases. Control measures, in turn, should focus on minimizing the transmission of pathogens to highly susceptible animal species (Munang’andu et al., 2012). In contrast, the birds (canaries, parrots) pose a potential hazard to human health since they could be carriers and vectors of zoonotic diseases such as chlamydia and salmonellosis, highly pathogenic avian influenza type A (H5N1) (Boseret et al., 2013). There is an urgent need to develop a holistic understanding of migration's potential both to increase and reduce the risk of infection of animals (Mckay & Hoye, 2016).

Understanding the broad patterns of host-parasite associations can help predict the emergence of new diseases in humans, domestic animals, and wildlife that will be important in developing effective programs to control emerging infectious diseases and neglected endemic diseases (Farrell et al., 2013). Parasitic diseases continue to represent a significant part of the overall morbidity in many countries globally, despite improved living conditions and increased awareness of health issues (Harizanov et al., 2020).

**Conclusions**

Active ingredients such as pyrantel pamoate (150±0.5 mg) and praziquantel (50±0.5 mg) as well as auxiliary substances of lactose, microcrystalline cellulose, calcium stearate, sodium chloride, the flavor of food "meat", povidone K-30, and potato starch are part of the antiparasitic drug. The antiparasitic drug is well tolerated in dogs and cats and does not give side effects and changes in animals' clinical state, and is an effective anthelmintic against cestodes or nematodes. The investigated veterinary drug can be used for therapeutic and prophylactic deworming in nematodes, cestodes, and mixed nematodes-cestodes invasions of dogs and cats. Our results could expand the range of domestic antiparasitic agents for veterinary medicine.

**References**

Arion, A., Fernández-Varón, E., Cárceles, C. M., Gagyi, L., & Ognean, L. (2018). Pharmacokinetics of praziquantel and pyrantel pamoate combination following oral administration in cats. Journal of feline medicine and surgery, 20(10), 900-904. doi: 10.1177/1098612X177734065

Atehmengo, N. L., & Nnagbo, C. S. (2014). Emerging animal parasitic diseases: a global overview and appropriate strategies for their monitoring and surveillance in Nigeria. The open microbiology journal, 8, 87-94. doi: 10.2174/1874285801408010087

Blashki, G., McMichael, T., & Karoly, D. J. (2007). Climate change and primary health care. Australian family physician, 36(12), 986-989. PMID: 18075618

Bogach, M. V., Paliy, A. P., Perots’ska, L. V., Pyvovarova, I. V., Stoyanova, V. Y., & Paliii, A. P. (2020). The influence of hydro-meteorological conditions on the spread of chicken cestodiasis. Regulatory Mechanisms in Biosystems, 11(3), 414-418. doi: 10.15421/022063

Bondarchuk, A. O., Paliy, A. P., & Blazheyevskiy, M. Ye. (2019). Determination of acute toxicity of the “Bondarmin" disinfectant. Journal for Veterinary Medicine, Biotechnology and Biosafety, 5(2), 26-30. doi: 10.36016/JVMBBS-2019-5-2-5

Boseret, G., Losson, B., Mainil, J. G., Thiry, E., & Saegerman, C. (2013). Zoonoses in pet birds: review and perspectives. Veterinary research, 44(1), 36. doi: 10.1186/1297-9716-44-36

Conboy, G. (2009). Helminth parasites of the canine and feline respiratory tract. Vet Clin North Am Small Anim Pract., 39(6), 1109-1126. doi: 10.1016/j.cvsm.2009.06.006
Day, M. J. (2011). One health: the importance of companion animal vector-borne diseases. Parasites & vectors, 4, 49. doi: 10.1186/1756-3305-4-49

Epe, C., Coati, N., & Schnieder, T. (2004). Results of parasitological examinations of faecal samples from horses, ruminants, pigs, dogs, cats, hedgehogs and rabbits between 1998 and 2002. Dtsch Tierarztl Wochenschr., 111(6), 243-247. PMID: 15287577

Fanning, S., Whyte, P., & O'Mahony, M. (2009). Essential veterinary education on the development of antimicrobial and antiparasitic resistance: consequences for animal health and food safety and the need for vigilance. Revue scientifique et technique, 28(2), 575-582. doi: 10.20506/rst.28.2.1905

Farrell, M. J., Berrang-Ford, L., & Davies, T. J. (2013). The study of parasite sharing for surveillance of zoonotic diseases. Environmental Research Letters, 8(1), 015036. doi: 10.1088/1748-9361/8/1/015036

Festing, S., & Wilkinson, R. (2007). The ethics of animal research. Talking Point on the use of animals in scientific research. EMBO reports, 8(6), 526-530. doi: 10.1038/sj.emboj.7400993

Fong, I. W. (2017). Animals and mechanisms of disease transmission. Emerging Zoonoses, 15-38. doi: 10.1007/978-3-319-50890-0_2

García-Agudo, L., García-Martos, P., & Rodríguez-Iglesias, M. (2014). Dipylidium caninum infection in an infant: a rare case report and literature review. Asian Pacific Journal of Tropical Biomedicine, 4(2), 565-567. doi: 10.12980/APJTB.4.2014APJTB-2014-0034

Gerhold, R. W., & Jessup, D. A. (2013). Zoonotic diseases associated with free-roaming cats. Zoonoses and public health, 60(3), 189-195. doi: 10.1111/j.1633-2928.2012.01522.x

Ghazy, R. M., Tahoun, M. M., Abdo, S. M., El-Bady, A. A., & Hamdy, N. A. (2020). Evaluation of praziquantel effectiveness after decades of prolonged use in an endemic area in Egypt. Acta Parasitologica, 2020. doi: 10.1007/s11686-020-00242-x

Guo, X. (2020). Proteomics Analysis of Hydatigera taeniaeformis Metacestode Stage. Front. Vet. Sci., 7, 474. doi: 10.3389/fvets.2020.00474

Harizanov, R., Rainova, I., Tsvetkova, N., Kaftandjiev, I., Borisova, R., Ivanova, A., & Videnova, M. (2020). Prevalence of intestinal parasitic infections among the Bulgarian population over a three year period (2015 – 2017). Helminthology, 57(1), 12-18. doi: 10.2478/helm-2020-0002

Ibrahim, A. M. A., Ahmed, H. H. S., Adam, R. A., Ahmed, A., & Elaagip, A. (2018) detection of intestinal parasites transmitted mechanically by House flies (Musca domestica, Diptera: Muscidae) infesting slaughterhouses in Khartoum State, Sudan. International Journal of Tropical Diseases, 1, 011. doi: 10.23937/ijtd-2017/1710011

Jimenez Castro, P. D., Howell, S. B., Schaefer, J. J., Avramenko, R. W., Gilleard, J. S., & Kaplan, R. M. (2019). Multiple drug resistance in the canine hookworm Ancylostoma caninum: an emerging threat? Parasites & Vectors, 12, 576(2019). doi: 10.1186/s13071-019-3828-8

Kabene, S., & Baadel, S. (2019). Bioethics: a look at animal testing in medicine and cosmetics in the UK. Journal of medical ethics and history of medicine, 12, 15. doi: 10.18502/jmehm.v12i15.1875

Kaplan, R. M. (2004). Drug resistance in nematodes of veterinary importance: a status report. Trends in parasitology, 20(10), 477-481. doi: 10.1016/j.pt.2004.08.001

Khasnis, A. A., & Nettleman, M. D. (2005). Global warming and infectious disease. Archives of medical research, 36(6), 689-696. doi: 10.1016/j.arcmed.2005.03.041

Koch, J., & Willesen, J. L. (2009). Canine pulmonary angiostrongylosis: an update. The veterinary journal, 179(3), 348-359. doi: 10.1016/j.tvjl.2007.11.014

Kopp, S. R., Kotze, A. C., McCarthy, J. S., & Coleman, G. T. (2007). High-level pyrantel resistance in the hookworm Ancylostoma caninum. Veterinary parasitology, 143(3-4), 299-304. doi: 10.1016/j.vetpar.2006.08.036

Kovalenko, V. L., Ponomarenko, G. V., Kukhtyn, M. D., Paliy, A. P., Bodnar, O. O., Rebenko, H. I., Kozytska, T. G., Makarevich, T. V., Ponomarenko, O. V., & Paliy, A. P. (2020). Evaluation of acute toxicity of the "Orgasept" disinfectant. Ukrainian Journal of Ecology, 10(4), 273-278. doi: 10.15421/2020_199

Lee, A. C., Schantz, P. M., Kazacos, K. R., Montgomery, S. P., & Bowman, D. D. (2010). Epidemiological and zoonotic aspects of ascarid infections in dogs and cats. Trends in parasitology, 26(4), 155-161. doi: 10.1016/j.pt.2010.01.002

Mackenstedt, U., Jenkins, D., & Romig, T. (2015). The role of wildlife in the transmission of parasitic zoonoses in peri-urban and urban areas. International Journal for Parasitology: Parasites and Wildlife, 4(1), 71-79. doi: 10.1016/j.ijppaw.2015.01.006

Mackenstedt, U., Schmidt, S., Mehlhorn, H., Stoye, M., & Traeder, W. (1993). Effects of pyrantel pamoate on adult and preadult Toxocara canis worms: An electron microscope and autoradiography study. Parasitol Res., 79, 567-578. doi: 10.1007/BF00932241

MacPherson, C. N. (2005). Human behaviour and the epidemiology of parasitic zoonoses. International journal for parasitology, 35(1-12), 1319-1331. doi: 10.1016/j.ijpara.2005.06.004

McKay, A. F., & Hoye, B. J. (2016). Are migratory animals superspreaders of infection? Integrative and Comparative Biology, 56(2), 260-267. doi: 10.1093/icb/icw054

Monzote, L. (2014). Development of natural products as antiparasitic agents. Current clinical pharmacology, 9(3), 181-186. doi: 10.2174/157488470903140806112509

Mukherjee, S., Mukherjee, N., Gayen, P., Roy, P., & Babu, S. P. (2016). Metabolic inhibitors as antiparasitic drugs: pharmacological, biochemical and molecular perspectives. Current drug metabolism, 17(10), 937-970. doi: 10.2174/138920201766616004143152

Ukrainian Journal of Ecology, 11(1), 2021
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Taglioretti, V., Sardella, N., & Fugassa, M. (2014). Effectiveness of coproscopic concentration techniques. Helminthologia, 51(3), 210-214. doi: 10.2478/s11687-014-0231-x

Tchuem Tchuenté, L. A., Momo, S. C., Stothard, J. R., & Rollinson, D. (2013). Efficacy of praziquantel and reinfection patterns in single and mixed infection foci for intestinal and urogenital schistosomiasis in Cameroon. Acta tropica, 128(2), 275-283. doi: 10.1016/j.actatropica.2013.06.007

Traversa, D., Di Cesare, A., & Conboy, G. (2010). Canine and feline cardiopulmonary parasitic nematodes in Europe: emerging and underestimated. Parasites & Vectors, 3, 62. doi: 10.1186/1756-3305-3-62

Trotz-Williams, L. A., & Trees, A. J. (2003). Systematic review of the distribution of the major vector-borne parasitic infections in dogs and cats in Europe. The Veterinary record, 152(4), 97-105. doi: 10.1136/vr.152.4.97

Vanco, L., Mortarino, M., Carro, C., Genchi, M., Pampurini, F., & Genchi, C. (2008). Field efficacy and safety of a combination of moxidectin and imidacloprid for the prevention of feline heartworm (Dirofilaria immitis) infection. Veterinary parasitology, 154(1-2), 67-70. doi: 10.1016/j.vetpar.2008.02.020

White, L. A., Forester, J. D., & Craft, M. E. (2017). Dynamic, spatial models of parasite transmission in wildlife: Their structure, applications and remaining challenges. Journal of animal ecology, 87(3), 559-580. doi: 10.1111/1365-2656.12761

Wolstenholme, A. J., Fairweather, I., Prichard, R., von Samson-Himmelstjerna, G., & Sangster, N. C. (2004). Drug resistance in veterinary helminths. Trends in parasitology, 20(10), 469-476. doi: 10.1016/j.pt.2004.07.010

Woods, D. J., Vaillancourt, V. A., Wendt, J. A., & Meeus, P. F. (2011). Discovery and development of veterinary antiparasitic drugs: past, present and future. Future medicinal chemistry, 3(7), 887-896. doi: 10.4155/fmc.11.39

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