VOL II

Estudos em Ciências Agrárias e Ambientais

Eduardo Spers
(Organizador)

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2024

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APRESENTAÇÃO

O campo das Ciências Agrárias e Ambientais desempenha um papel fundamental na compreensão e solução dos desafios contemporâneos relacionados à produção de alimentos, à conservação ambiental e ao bem-estar animal. Em um mundo em constante transformação, questões como a sustentabilidade dos agroecossistemas, o manejo eficiente dos recursos naturais e a saúde pública se tornam cada vez mais relevantes. É com este espírito que apresentamos o volume II da coletânea "Estudos em Ciências Agrárias e Ambientais", que reúne pesquisas de autores de diversas partes do mundo, cada um contribuindo com sua perspectiva e expertise únicos.

Os quinze artigos que compõem este volume abordam uma variedade de tópicos, refletindo a riqueza e a diversidade das Ciências Agrárias. Desde práticas conservacionistas que buscam melhorar e manter agroecossistemas, até investigações sobre o uso de fitohormonas e fertilização na produção vegetal, o uso de tecnologias de processamento de madeira e a promoção do bagre armado - cada estudo traz à tona questões cruciais que impactam tanto a produção agrícola quanto a saúde ambiental.

Neste volume, também exploramos a crescente relevância dos produtos agrícolas locais, especialmente em tempos desafiadores como os que vivemos, marcados pela pandemia da COVID-19. A importância de circuitos curtos de proximidade se torna evidente, promovendo não apenas a segurança alimentar, mas também a resiliência das comunidades.

Além disso, as contribuições da veterinária destacam a importância do cuidado animal e da saúde pública, ilustrando a interconexão entre os seres humanos, os animais e o meio ambiente.

Esperamos que esta coletânea não apenas informe, mas também inspire debates e colaborações futuras entre pesquisadores, profissionais e estudantes da área. Juntos, podemos avançar em direção a um futuro mais sustentável e equilibrado, em que conhecimento pesquisa sejam os pilares para soluções efetivas.

Agradecemos a todos os autores e colaboradores que tornaram este trabalho possível. É nossa esperança que os estudos aqui apresentados contribuam para um entendimento mais profundo das questões agrárias e ambientais, e que possam servir de base para novas investigações e práticas inovadoras.

Eduardo Eugênio Spers

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PARASITIC CONTAMINATION OF PUBLIC PLACES IN BELGRADE AND ITS CONTROL RESULTS OF A THIRTY-YEAR STUDY (1993-2023)

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ABSTRACT: The presence of pets, particularly dogs, significantly enriches urban life by offering psychological benefits and enhancing socialization among children, while concurrently posing public health risks due to increasing populations of both owned and stray dogs. Urban areas globally are grappling with serious challenges, including injuries from dog attacks and contamination from dog feces, which can harbor zoonotic parasites. This study examines the contamination levels in public spaces, particularly in Belgrade, where a comprehensive monitoring program has been implemented since 1993. The research tracks the prevalence of harmful parasites in parks and playgrounds, revealing alarming contamination rates that pose significant health risks. Despite substantial improvements in urban hygiene due to public health initiatives and responsible pet ownership, challenges remain. The study outlines effective management strategies, including regular parasitological monitoring, public education, and legislative enforcement. Findings suggest that humane approaches to managing stray dog populations, alongside continuous community engagement, can significantly reduce contamination levels and improve public health outcomes.

KEYWORDS: Urban health. Stray dogs. Zoonotic parasites. Public hygiene. Animal welfare. Contamination control. Belgrade. Epidemiology. Public education. Legislative enforcement.

1 INTRODUCTION

Pets, especially dogs, play a significant role in the lives of modern people, especially in

the urban environment. Alienation, stress, and other factors that burden the city man are often psychologically overcome by acquiring a dog, which, with its devotion, represents excellent psychotherapy (which in some countries is generally accepted as a prevention of psychological and stress-related diseases such as high blood pressure, heart disease or increased cholesterol).It has also been noted that socialization develops more easily in children who have pets, and in old people, life expectancy increases and the tendency to depression decreases

Unfortunately, in addition to this favorable influence, the presence of dogs in urban areas has another side. The increase in the number of owned and abandoned dogs in cities is a current problem of global proportions. Every year, the number of people injured by dogs increases, and their excrement is a particular problem. In the close cohabitation of stray dogs and pets that are in the immediate environment of people, there is constant contamination of public areas, especially streets and parks, with dog feces. In the urban environment, green areas and parks are the main places where children play and they are resting places for city people, but they are also places where dog owners take their pets out and places where we meet non-owner dogs - usually former pets. If it is known that a dog excretes an average of 100 grams of feces per day, it is easy to determine, based on an insight into the number of animals in the city, that the amount of dog excrement that is excreted daily passes several tons per day.

Dog excrement, apart from its unpleasant appearance and smell, represents an epidemiological danger considering that dogs are carriers and real hosts of a large number of species of zoonotic parasites. Among the many types of parasites that dogs are real hosts for *Toxocara canis, Ancylostomidae* sp., *Echinoccocus granulosus*, *Dipylidium caninum, Taenia* sp., *Trichuris vulpis* and *Strongyloides stercoralis* and oocysts of the protozoa *Giardia intestinalis, Amoeba* sp. and *Cryptosporidium* sp.

Dog owners are certainly the population most exposed and threatened by parasitic zoonoses. Toxocariasis has been observed much more often in dog breeders who do not take enough care to deworm their dogs, especially since toxocariasis is incomparably more common in puppies than in adult dogs. Refers to children who tend not to wash their hands after contact with animals or have a habit of geophagy. In semi-rural and rural areas, dogs defecate unhindered on vegetables, so unwashed vegetable food can be a significant source of infection if it is not well washed. Likewise, in urban areas, feces that are on in the streets during the summer it is dried up and parasite eggs can infect people through inhalation. In the case of rain, the excrement dissolves, creating a microemulsion on the pavement, lawns and public areas, and

together with parasite eggs, they are easily carried into houses on shoes, becoming a source of infection.

2 CONTAMINATION OF URBAN AREAS IN THE WORLD

Contamination of urban areas with dog excrement is a ubiquitous problem of global proportions to which highly developed countries are equally exposed, almost to the same extent as third world countries. The difference is only in the types of parasites (due to geographical position, climatic and socioeconomic factors) and the dogs that carry them. In countries with a high standard, they are pet animals, while developing countries are threatened by stray dogs. Either way, *Toxocara canis, Ancylostomidae* spp., *Echinoccocus granulosus, Strongyloideus stercoralis, Dipyllidium caninum, Giardia intestinalis* or *Amoeba* spp. they don't know borders, dog breeds or owner statutes, they will infect them all equally if given the chance.

In semi-rural and rural areas, dogs defecate unhindered on vegetables, so unwashed vegetable food can be a significant source of infection if it is not well washed. Likewise, in urban areas, feces that are on in the streets during the summer it is dried up and parasite eggs can infect people through inhalation. In the case of rain, excrement dissolves, creating a microemulsion on pavements, lawns and public areas, and together with parasite eggs, they are easily brought into houses on shoes, becoming a source of infection. Looking back at the results of parasitological surveys of public areas in cities around the world, we will see that this contamination with eggs of zoonotic parasites constitutes a global problem.

For example, in Madrid it was 9%, London 15-17%, Michigan 19%, Kansas 20.6%, Utrecht 23%, Belgrade, Paris and Prague 28%, Dublin 32%, Naples 48%, Tokoshima 63% etc. If it is known that more than 5% of polluted surfaces represent a serious danger to people's health, we are of the opinion that this should not be commented on.

The ecological and epidemiological implications of the problem are attracting the attention of eminent experts, and although this problem on a global scale is not new, its solution is still the subject of numerous analyses, discussions and conflicting opinions, ranging from the principle of total removal of animals from the streets to much more humane and acceptable solutions such as NKS (No Kill Strategy) and CNR (Catch-Neuter-Release). Such programs are also supported by leading international animal protection organizations WSPA (The World Society for the Protection of Animals), RSPCA (Royal Society for the Prevention of Cruelty to Animals International), IFAW (International Fund for Animal Welfare), HSI (Humane Society International), the World Small Animal

Veterinary Association and the Alliance for Rabies Control, so the creation of such a strategy requires full cooperation with them and with all other organizations whose goal is animal welfare.

Public interest in the welfare of animals is growing and is increasingly present in the world, as well as in our society. This trend inspires numerous debates and discussions about animal welfare as well as ways and problems that arise when solving the problem of abandoned animals. Factual and scientific knowledge in this area must support and inform ethical decisions, and especially the need to understand the affective states of animals (the problem of interaction with people) and their needs in relation to the environment in which they move and find themselves. Animal welfare is the course that we should follow in applying methods to solve the problem of abandoned animals.

The positions to be defended, which concern the welfare of animals, require scientific knowledge about the biology of animals, in order to enable the closest determination of their physiological, health and psychological needs, as well as to better solve the problems and issues of their impact on the environment and people's health.

3 EPIDEMIOLOGICAL IMPORTANCE OF THE MOST COMMON HELMINATES OF DOGS

The most common and perhaps the best known parasitic diseases transmitted by dogs are echinococcosis, toxocariasis and hookworm. None of them develop into adult parasites in humans, but their developmental forms (cysts or migratory larvae) cause serious illnesses, even death.

3.1 ECHINOCCOCOSIS

Echinococcosis is a zoonotic disease that is caused by tapeworms of the genus *Echinococcus*. *Echinococcus* adult worms develop from protoscolices and are typically 6 mm or less in length and have a scolex, neck and typically three proglottids, one of which is immature, another of which is mature and the third of which is gravid (or containing eggs). Carnivores act as definitive hosts for the parasite, and harbour the mature tapeworm in their intestine. The definitive hosts are infected through the consumption of viscera of intermediate hosts that contain the parasite larvae. A number of herbivorous and omnivorous animals act as intermediate hosts of *Echinococcus*. They become infected by ingesting the parasite eggs in contaminated food and water, and the parasite then develops into larval stages in the viscera.

Humans act as so-called accidental intermediate hosts in the sense that they acquire infection in the same way as other intermediate hosts, but are not involved in transmitting the infection to the definitive host. The two most important forms, which are of medical and public health relevance in humans, are cystic echinococcosis (CE) and alveolar echinococcosis (AE).

Human infection with *E. granulosus* leads to the development of one or more hydatid cysts located most often in the liver and lungs, and less frequently in the bones, kidneys, spleen, muscles and central nervous system. The asymptomatic incubation period of the disease can last many years until hydatid cysts grow to an extent that triggers clinical signs, however approximately half of all patients that receive medical treatment for infection do so within a few years of their initial infection with the parasite.

Alveolar echinococcosis is characterized by an asymptomatic incubation period of 5–15 years and the slow development of a primary tumour-like lesion which is usually located in the liver. Clinical signs include weight loss, abdominal pain, general malaise and signs of hepatic failure.

3.2 TOXOCARIASIS

The large roundworms (ascaridoid nematodes) of dogs and cats are common, especially in puppies and kittens. Two species, *T canis* and *T leonina*, infect dogs and are found globally. For all species, adult parasites are stout cream-colored nematodes that are found in the small intestine and typically range from 3 to 15 cm in length. In dogs, the most important roundworm is *T canis*, not only because its larvae may infect humans but also because infections are generally common and may impact puppy health. Also, fatal infections may occasionally occur in young pups. In puppies, the most common mode of infection is transplacental transfer. If pups < 3 months old ingest embryonated infective eggs, the hatched larvae penetrate the intestinal mucosa and reach the lungs via the liver and bloodstream. Then they are coughed up and swallowed, maturing to egg-producing adults in the small intestine. The prepatent period ranges from 2 to 3 weeks after prenatal infection to 4 to 5 weeks after ingestion of eggs or paratenic hosts.

Dogs typically develop immunity to *T canis* with age. However, during the perinatal period, the immunity of the bitch to infection is partially suppressed, and substantial numbers of eggs may be passed in the feces of the bitch. Development of these patent infections appears to be associated with maturation of arrested larvae in the bitch, which migrate to the intestine via the lungs. Patency may also occur as a result of ingestion and maturation of larvae that are passed in the feces of puppies. Eggs of *T canis* become infective (larvae) after ~2–4 weeks in the environment.

Human infection with *T.canis* occurs through ingestion of parasite eggs. Larvae emerge from the ingested eggs in the intestines and start migrating through the bloodstream, and during migration they stop in the lungs, brain, heart, eyes and other organs, causing significant diseases (the disease is known as visceral larva migrans syndrome). Adult parasites do not develop in humans. A milder form manifests itself with skin changes and lymphadenopathy. The more severe form, which is most often encountered in children, is characterized by cough, chronic obstructive bronchitis, asthma, recurrent eosinophilic pneumonia, high temperature, enlargement of the spleen and liver, meningitis, encephalitis, epilepsy, convulsions, abdominal disorders, nausea, anorexia, myocarditis, myocardiopathies, etc. Fatal outcomes are possible.

T leonina is present in adolescent/adult dogs and is a less common infection than *T canis*. Dogs become infected via ingestion of infective eggs and infected paratenic hosts (eg, rodents). Infections are not zoonotic.As in dogs, *T leonina* infections are acquired via ingestion of infective eggs and larvae in paratenic hosts, eg, rodents; migration is restricted to the intestinal wall so that neither prenatal nor transmammary transmission occurs. Infections are not zoonotic.

3.3 ANCYLOSTOMA SP.

Hookworms (*Ancylostoma* spp, *Uncinaria stenocephala*) are common infections of dogs and cats, particularly puppies and kittens. Some species are zoonotic. Multiple hookworm species infect dogs and cats. *A caninum* is the principal cause of canine hookworm disease in most tropical and subtropical areas of the world and is considered the most pathogenic of the dog hookworms. *A caninum* has become more common than *U stenocephala* in dogs Adult hookworms reside in the small intestine. *A caninum* males are ~12 mm long and females ~15 mm; the other species are somewhat smaller.

Thin-walled hookworm eggs in the early cleavage stages (2–8 cells) are first passed in the feces 15–20 days after infection; they complete embryonation and hatch in 24–72 hours on warm, moist soil. For all hookworm species, transmission may result from ingestion of infective larvae from the environment and additionally, in the case of *A caninum*, via the colostrum or milk of infected bitches. Infections with *A caninum* can also result from larval invasion via the skin; however, this route is of little significance for *U stenocephala*.

Skin penetration in young pups is followed by migration of the larvae via the blood to the lungs, where they are coughed up and swallowed to mature in the small intestine. However, in animals > 3 months old, *A caninum* larvae, after migration via the lungs, are

arrested in the somatic tissues, e.g., muscle, fat, and mucosa of small intestine. These arrested larvae may be activated during pregnancy, then accumulate in the mammary glands. Reactivation of dormant larvae, which may also occur after removal of adult worms from the intestine and for other unknown reasons, results in development of patent infections and is referred to as “larval leak.”

Human infections with members of the Ancylostomida spp. (*Ancylostoma caninum* and *Uncinaria stenoephala* in our environment) are caused by penetration of the larvae through the skin and ingestion. The migration routes are similar in both cases, but adult parasites never appear in humans. The disease manifests itself in the form of skin changes - redness, swelling, inflammation; often the surrounding lymph nodes can also be affected. More severe cases of dermatitis are also possible while fatal cases of this syndrome known as cutaneous larva migrans have not been reported.

Apart from them, *Strongyloideus stercoralis, Dipyllidium caninum, Taenia multiceps* and *Trichuris vulpis* are zoonotic helminths of dogs too.

4 INFLUENCE OF ENVIRONMENTAL FACTORS ON THE PREVALENCE OF GEOHELMINATES

The vast majority of helminth eggs found in public areas are from the group of geohelminths - parasites whose development takes place in the soil, so that the thrown eggs become infectious for animals and humans only in the external environment. All over the world, the eggs of *T. canis* and *Ancylostomida* spp are the most numerous. - parasites with the greatest zoonotic potential.

The degree of infection of public spaces with geohelminths depends on the number of parasite eggs per kg of soil, and the speed of parasite development on the microclimate conditions prevailing in certain parts of the year. Thus, when studying this type of pollution and assessing the risk of human infections, we must be guided by the knowledge of bioclimatic conditions so that taking samples and interpreting the results are consistent with the actual situation on the ground.

The correlation between the climate (that is, the climatogram that shows it) and the appearance, distribution, number, and rapid development of living beings is very strong. If data on the vital optimum, development and generations of living beings during the year are included in the climatogram, it is then a bioclimatogram. Bioclimatograms are useful for showing, explaining or forecasting the occurrence or absence of a species in increased or decreased abundance. Therefore, there is a strong correlation of microclimate conditions with the dynamics of biological phenomena, and therefore a mutual correlation

of biological phenomena that take place in those conditions of the park areas of Belgrade were guided by a bio-climatogram according to Uvarovo in order to determine the optimal time of taking samples for inspection and evaluation of the obtained results.

Based on previous research, a change in parasitofauna was observed, which was caused by the influence of climate changes in Belgrade during the last decades. The prevalence of certain parasitic species is significantly lower, and at the same time, species of parasites that were not previously present in this area have appeared. This trend had its upward trend in the last few years, when there were more drastic climate changes - with mild winters, very hot summers, a large amount of atmospheric precipitation, etc. This was reflected in the biodiversity, prevalence and incidence of the parasitic fauna of the green areas of Belgrade in the period from 1993, when these continuous researches began until today.

Changes in the microclimate, which in the last few years had a significantly greater temperature oscillation (significant increase in average temperature and air humidity), are particularly favorable for the development of certain geohelminths. Looking from an epidemiological point of view, the dominant type of parasite is T. canis parasite, whose embryonic development in eggs takes place in the soil and which is directly dependent on the prevailing microclimate. At a temperature of 25 degrees, eggs embryonate in 7-12 days and at a temperature of 25 degrees in 5 days. Eggs are inactivated at a temperature higher than 37 degrees, before the formation of larvae. At a temperature of 50 degrees, they are inactivated in 5 hours, and at a temperature of 55 degrees in 1 hour. Direct sunlight inactivates them very quickly. in the specified period.

Changes in the microclimate, which in the last few years had a significantly greater temperature oscillation (significant increase in average temperature and air humidity), are favorable for the development of certain geohelminths, which have the greatest epidemiological significance as the cause of human toxocariasis, better known as larval migrans syndrome.

Based on previous research, a change in the parasitofauna was observed, which was caused by the influence of climate changes in Belgrade during the last decades. The prevalence of certain parasitic species is significantly lower, and at the same time, species of parasites that were not previously present in this area have appeared. This trend had its upward trend in the last couple of years, when there were more drastic climate changes - with mild winters, very hot summers, a large amount of atmospheric precipitation, etc. This was reflected in the biodiversity, prevalence and incidence of the parasitic fauna of the green areas of Belgrade in the period from 1993, when continuous research began until today 2023.

The conclusion of our research, which was carried out for thirty years, is that a change in the parasitofauna was observed, which was caused by the influence of climate changes in Belgrade during the last decades. The prevalence of certain parasitic species is significantly lower, and at the same time, species of parasites that were not previously present in this area have appeared. This trend had its upward trend in the last few years, when there were more drastic climate changes - with mild winters, very hot summers, a large amount of atmospheric precipitation, etc. With a significant decline in the hygiene of city parks and streets, at least as far as dog excrement is concerned, which irresponsible owners let defecate wherever they go and do not clean up after them, only worsen the epidemiological aspect of this problem.

5 METHOD OF PARASITIC CONTROL CONTAMINATION OF GREEN AREAS

In order to solve the problem of fecal and parasitological contamination of public areas basic starting point is a regular examination were green spaces and dog faces caught on them in order to gain insight into the epidemiological situation and start the rehabilitation and eradication of contaminated places. Also, it is necessary for local governments to define the program of non-proprietary control animals in their environment.

5.1 PLACES

Samples of soil and grass samples and dog faeces were taken from the parks and public places in central city municipalities - Stari Grad, Palilula, Vračar and Savski Venac. Examinations were carried out in the following parks and green area: Tašmajdan Park, Mali Tašmajdan, Čuburski Park, Manjež Park, Academic Park, Kalemegdan, Pionirski Park, Terazijski plato and Botanic Garden.

5.2 SAMPLING

Since 1993, every year, the same numbers of soil and grass samples and dog faeces were taken from the same parks (64 soil and 64 feces samples twice on year, each year). The material for examination is taken in the form of a group sample of soil, grass and dog excrement, the number of which depends on the size of the location, and sand from children's playgrounds is taken from each of the small pools in the mentioned locations. Each sample is packed in PVC bags, on the outside of which the location, sample number and date of sample collection are recorded.

Samples of grass and soil from green areas were collected from March to October. The material for examination was taken on the basis of indicators of bioclimatic conditions

prevailing in the same area leading to the method of bioclimatograme by Uvarov, where the components have average values for temperature and humidity for the studied area. This is of particular importance for assessing the results with respect to embryonation of geohelminths in soil (become infective), under certain conditions like the optimum temperature and humidity.

5.3 METHODS OF EXAMINATION OF DOG FECES

The examination is performed using the native preparation method and the flotation method (according to McMaster, Stoll and Richardson-Kendell). Determining the severity of the infection is done by the McMaster method with the application of corrective factors, as well as by the Stoll method with corrective calculation.

5.4 SOIL EXAMINATION METHODS

The examination is carried out using the sedimentation and flotation method as well as the modified method according to Pavlovic. The intensity of the infection is determined using the method according to McMaster and Stoll. We presented modified method of testing soil and sand for the presence of parasite eggs according to Pavlovic, protected by the Institute for Intellectual Property of the Republic of Serbia; certificate no. 2770/2017 A-0098/2017 serial no. under which it was entered in the records: 8430.

Equipment required for work: 2 laboratory beakers with a volume of 1000 ml, 1 conical sedimentation beaker with a volume of 250 ml, a graduated vessel of 100 ml, a laboratory balance, a physiological solution (protected with 650 g of glucose per liter), a stirring stick, parasitological sieves with an opening size of 250, 150 and 45 micrometers, plastic strainer, pipettes, McMaster counting chamber and microscope with 40x to 100x magnification. **Performance:** - Take 100 g of the sample in a laboratory beaker with a volume of 1000 ml. Pour 500 ml of tap water into and mix the sample and water well - Immediately after mixing, pour the suspension through a parasitological sieve with openings of 250 micrometers into a laboratory beaker with a volume of 1000 ml and leave for 10 minutes to sediment - Drain the liquid and pour 500 ml of tap water on the sediment and mix the sample and water - Immediately after mixing, pour the suspension through a parasitological sieve with openings of 125 micrometers into a laboratory beaker with a volume of 1000 ml and leave for 10 minutes to sediment - Drain the liquid and pour 500 ml of tap water on the sediment and mix the sample and water - Immediately after mixing, pour the suspension through a parasitological sieve with openings of 45 micrometers into a laboratory beaker with a volume of 1000 ml and leave

for 10 minutes to sediment - Measure 4g of sediment with a pipette, transfer it to a conical sedimentation beaker and add 56ml of physiological solution with a graduated vessel - The sample is taken with a pipette immediately after filtering when the suspension is still well mixed. - Pour both sides of the McMaster counting chamber with the suspension, taking care not to create air bubbles, and let it stand for 3-5 minutes before counting. in order for the eggs to settle - In the final stage of McMaster's numerical chamber, it is placed on a microscope slide and examined under a microscope with a magnification of 40-100 x. - When counting the engraved spaces, one should follow the general rule of counting: one should count all the eggs inside the grid plus all the eggs that touch the two sides of the grid (i.e. the upper and left boundary lines), and not take into account all the eggs that touch the other two sides grids (ie lower and right boundary lines). - In McMaster's technique, 15 ml of suspension represents 1 g of sample, and as 0.3 ml is examined, which represents 1/50 g, the total number of eggs in both sides of the chamber should be multiplied by 50.

5.5 DETERMINATION OF PARASITES

In both cases, the determination of adults, eggs and oocysts of the parasite is performed by morphometric analysis based on morphological characteristics.

All these years, the researches were organized and carried out in the laboratory for parasitology of Scientific Institute of Veterinary Medicine of Serbia. For easier monitoring of the results, they are shown in average value for five-year periods as we did during the research.

6 RESEARCH RESULTS IN THE PERIOD 1993-2023

In order to properly perceive the current situation, some basic facts that preceded it must be known. Until the beginning of the 90s, Belgrade had a negligible population of unowned dogs, and there were legal provisions obliging pet owners to do mandatory deworming, clean public areas after them and responsible ownership. As a result, public areas, parks and green spaces were minimally contaminated with dog feces. At the beginning of the 90s and the breakup of Yugoslavia, there was a state of war in the surrounding area, UN sanctions on the FRY, inflation, etc. These negative events lead to an economic crisis and the consequent abandonment of pets by old owners who could not financially support them. These animals bred freely, and the population of stray dogs grew significantly and became a city problem, as did the contamination of public areas with their feces.

6.1 EXAMINATION IN PERIOD 1993-1996

For these reasons, in 1993, the first investigations into the contamination of parks and green areas in Belgrade began. During the first years of research (1993-1996) it was established that 65,90 % of soil samples, 12.5% of sand samples from children's playgrounds and 59.23% of dog feces samples contained parasite eggs. At examined locations eggs of *Toxocara canis* were found in 48,76% soil samples, *Ancylostomidae* sp. in 39,23%, *Dipylidium caninum* in 33.96%, *Trichuris vulpis* in 14.29% and *Taenia* sp. in 7.19%.

At same time in dog faeces eggs of *Toxocara canis* were found in 69.90%, *Ancylostomidae* sp. in 49.96%, *Dipylidium caninum* in 49.62%, *Trichuris vulpis* in 14.99% and *Taenia* sp. in 10.71%. *Isospora* sp. was found in 1,21%, *Giardia intestinalis* in 0.11%, *Amoeba* sp. in 0.02% and *Cryptosporidium* sp. in 0.01%.

The Secretariat for Environmental Protection of Belgrade was informed of the results of the research and measures were taken to control stray dogs and clean children's playgrounds.

6.2 EXAMINATION IN PERIOD 1997-2002

In the period 1997-2002, began the arrangement of the city's central park areas, which was reflected in the general reduction of the pollution of sand for children's play to only 0.2% and green areas to 50.22 %. Durng examination period eggs of *Toxocara canis* were found in 46.56%, *Ancylostomidae* sp. in 37.31%, *Dipyllidium caninum* in 33.43%, *Trichuris vulpis* in 10.93%. *Toxascaris leonina* in 7.81% and *Taenia* sp in 6.12%

In dog faeces eggs of *Toxocara canis* were found in 65.90%, *Ancylostomidae* sp. in 41.96%, *Dipylidium caninum* in 44.62%, *Trichuris vulpis* in 11.99% and *Taenia* sp. in 7.71%. *Isospora* sp. was found in 1,11%, *Giardia intestinalis* in 2.32%, *Amoeba* sp. in 1.02% and *Cryptosporidium* sp. in 0.12%.

6.3 EXAMINATION IN PERIOD 2003-2007

During the next five years (2003-2007), extensive rehabilitation of park areas and educational activity through the media about responsible ownership and the importance of dog parasites for human health continued. This was done through TV and radio broadcasts, education of children in kindergartens and through leaflets.

The results were already seen during subsequent controls, when contamination was found on 45.90% of the examined surfaces. *Toxocara canis* was found in 42.82% of samples, *Dipylidium caninum* in 37.19%, *Ancylostomidae* sp. in 31.70%, *Taenia* sp. .in 4.31%, *Toxascaris leonina* .in 3.65% and *Trichuris vulpis* in 2.43%. At same time in dog faeces

eggs of *Toxocara canis* were found in 42.80%, *Ancylostomidae* sp. in 37.19%, *Dipylidium caninum* in 31.62%, *Trichuris vulpis* in 7.92% and *Taenia* sp. in 5.71%. *Isospora* sp. was found in 3.22%, *Giardia intestinalis* in 5.01% and *Amoeba* sp. 3.31% and *Cryptosporidium* sp. in 0.11%.

6.4 EXAMINATION IN PERIOD 2008-2011

In the period 2008 - 2011, visual instructions, notices and markings were made for areas designated for off-leash dogs as well as where dogs are not allowed. In the same period, a system of baskets with PVC bags for the disposal of dog feces (doggy-pot system) was created, and since 2011, eco zones or dog parks have been formed in some parks.

Based on the performed parasitological control of soil contamination from parks, the presence of parasite eggs was found in 39.06%. Eggs of *Toxocara canis* were found in 36.56%, *Ancylostomidae* sp. in 27.31%, *Dipyllidium caninum* in 23.43%, *Trichuris vulpis* in 10.93%, *Strongyloides stercoralis* and *Toxascaris leonina* in 7.81% and *Taenia* sp in 6.12%.

In dog faeces eggs of *Toxocara canis* were found in 31.36%, *Ancylostomidae* sp. in 32.50%, *Dipylidium caninum* in 35.62%, *Trichuris vulpis* in 14.99% *Toxascaris leonina* 5.11%, *Strongyloudes stercoralis* 4.00% and *Taenia* sp. in 4.19%. *Isospora* sp. was found in 2.32%, *Giardia intestinalis* in 19.37 %, *Amoeba* sp. in 10.11% and *Cryptosporidium* sp. in 5.01%.

The biggest step forward in solving this problem was made in the period 2010-2011. A special segment in Belgrade has been the adoption of problem-solving strategies in the city of Belgrade for stray dogs and cats, which was adopted at the Belgrade City Assembly held 2011. developing this Strategy for the City of Belgrade and its implementation was guided by the principle of humanity. It combines the method of no kill strategy and CNR method “catch - treat - let “ (CNR - catch - neuter -release), with special emphasis on the protection of human and animal health and applying education, control and sanctions against irresponsible owners whose negligence and disregard of legal rules and moral principles directly cause an increase in the number of abandoned dogs. The city of Belgrade has become one of the few cities that has a strategy to solve the problem of stray dogs and defines the principles, objectives and measures to solve the problem of stray dogs by administration of the local government.

6.5 EXAMINATION IN PERIOD 2012-2016

In the period 2012-2016, the trend of building dog parks within city parks continued, the education program on responsible ownership and landscaping of public

areas continued. Control of green areas and parks showed that the percentage of contamination decreased to 30.45%. In this period the average percentage of *Toxocara canis* eggs found was 29.68%, *Ancylostomidae* sp. 21.18%, *Dipyllidium caninum* 26.56%, *Strongyloides stercoralis* 6.81%, *Toxascaris leonina* 5.97%, and *Trichuris vulpis* 2.68% and *Taenia* sp. 2.25%.

In dog faeces eggs of *Ancylostomidae* sp. were found in 31.96%, *Toxocara canis* in 29.90%, *Dipylidium caninum* in 25.62%, *Strongyloides stercoralis* in 5.78%, *Toxascaris leonina* 4.91%, *Trichuris vulpis* in 1.39% and *Taenia* sp. in 2.71%. *Isospora* sp. was found in 3.32%, *Giardia intestinalis* in 16.37 %, *Amoeba* sp. in 9.51% and *Cryptosporidium* sp. in 2.01%.

6.6 EXAMINATION IN PERIOD 2017-2023

The results indicate that the implementation of this strategy stabilized the population of stray animals and implementation of mass sterilization resulted in a 50% reduced increase of abandoned dogs in full cooperation with all the other organizations with animal welfare goals. The positive effect of these measures was observed during regular parasitological controls of parks and green areas. During 2023, the presence of parasite eggs in public places was >65% less than in the period before the introduction of all these preventive measures and presented it 27.37%. [56]

In dog faeces eggs of *Ancylostomidae* sp. were found in 29.16%, *Toxocara canis* in 28.37%, *Dipylidium caninum* in 27.42%, *Strongyloides stercoralis* in 4.78%, *Toxascaris leonina* in 4.39%, *Trichuris vulpis* in 1.09% and *Taenia* sp. in 1.71%. *Isospora* sp. was found in 1.12%, *Giardia intestinalis* in 22.34 %, *Amoeba* sp. in 9.92% and *Cryptosporidium* sp. in 1.17%.

7 METHODS OF REMEDY OF CONTAMINATION

In addition to reducing the number of animals from the streets, it is necessary to undertake a series of measures that are necessary for an adequate solution to this problem on a long-term level. This problem should therefore be approached from several aspects and with the involvement of all structures of the city. This could best be illustrated through the example of the periodic resolution of this problem in Belgrade.

Although the lack of continuity of certain segments has been particularly present in the last few years, past experiences have given us the right that the remediation of this problem is best done when:

1. Regular parasitological control of parks, green areas and children's sand playgrounds and remediation of the established condition
2. By including the media in the actions undertaken
3. By educating the population
4. Legislation
5. Adopting the Strategy for Solving the Problem of unwonted Dogs

1. Regular parasitological control of parks, green areas and children's sand playgrounds and remediation of the established condition

This control is performed periodically and appropriate hygiene measures are taken based on the results. Based on the findings, the sand should be changed by replacing the surface layer to a depth of 6 cm, and in all places in parks and other green areas, the constant cleaning of dog feces should be organized and, if necessary, the contaminated area should be disinfected. In order to monitor the parasitic contamination of parks and other green areas of Belgrade, since 1993, continuous monitoring of their pollution has been carried out. Inspections are carried out in four central city municipalities where there are the most parks in the city.

They resulted in continuous changes in the way of thinking and contributed to the implementation of numerous changes within the city's communal hygiene, which led to a significant improvement in the quality of these areas and the constant improvement of its protection and thus the health of the people who live here.

2. Media in the actions undertaken

During the actions, the media should be engaged in order to support and acquaint the population with the importance of the implemented actions. The media should influence the propagation of these actions and influence the inclusion of as wide a population as possible in it. Media actions must be conducted in such a way that they do not cause negative reactions from animal protection societies and the like.

Organizations that know how to permanently hinder progress in this industry. In this way, the activists of those groups should be drawn into the normal framework of action in order to cancel their unprofessional actions. In this way, they will focus on a much more cooperative approach to solving the problem of non-owner dogs and allow their care in private shelters to be under the control of veterinarians, as well as the care of animals that are on the street. Eg. activities in this direction, which were carried out in the period 2011-2012, gave a lot of positive progress and in many ways helped to implement the adopted strategy of the city for taking care of stray dogs.

3. Education the population

Perhaps one of the key segments is the education that should include dog owners, considering the large amount of ignorance of the possible role that their pets play in the spread of certain diseases transmitted by dogs, which in case of infection of pets, they are primarily at risk. In this way, their irresponsible behavior and letting dogs onto green areas and children's playgrounds will be avoided or at least reduced. They should also be reminded of the importance of periodic parasitological examinations and deworming of pets. The owner's opinion that taking dogs into the vicinity of the house is not dangerous is completely wrong, because the eggs of these parasites are brought into the house through the shoes and dirty hands of the owners who have been in contact with other dogs.

The education of children in pre-school and school institutions is also of particular importance, considering that a large number of them have a dog as their pet or come into contact with stray animals. Children should be introduced to the behavior of dogs, emphasis should be placed on washing hands after playing with dogs and in the park or on the sand, etc. but also with the potential dangers that threaten them from dogs (injuries, infections, etc.). This should be presented in an accessible and easy way for children, and positive examples were teaching children in kindergartens and taking children to the first open asylum for dogs where they had contact with animals with explanations adapted to their age.

The education of parents of children is even more important, and to this end lectures by experts should be held simultaneously for children and parents, especially in preschool institutions.

Education of health workers (pediatricians), considering that the problem of larva migrans and other parasitoses is not yet given enough attention, should be educated through seminars, which would involve them equally in the action of educating patients.

The education of veterinarians, primarily those engaged in small practices, should also be carried out through seminars. Their work should also be focused on the education of owners in controlling helminths and the need for regular coprological control of pet dogs.

To that end, this problem should be presented in several ways. First, it is necessary to start issuing posters, leaflets and brochures that will deal with this problem in an accessible way (in pictures and words). Care should be taken to issue publications in which this problem is brought closer to the population in a clear and concise manner with an appropriate textual and graphic solution.

Education should also be carried out through the media - radio, television and print. Depending on the level of the magazine, the texts should be adapted so as to point out all the actuality, importance and measures that should be taken for the purpose of preventing infections (hygiene of keeping dogs, deworming, obligations of the owner in relation to walking dogs, the possibility and way of infection of children and the need for personal hygiene etc.). The same concept should be followed when presenting on this topic in radio and TV shows, with the fact that veterinarians and doctors should also be included in them.

4. Legislation

Legislation related to animal welfare, keeping and walking dogs and other regulations related to communal hygiene should be rigorously implemented with all punitive measures against the owners. For that, there is now a municipal police force that should work in accordance with its powers.

5. Adopting the strategy for solving the problem of unwonted dogs

The city of Belgrade is one of the few cities that has a strategy for solving the problem of unowned dogs, and this is a document that defines the principles, goals and measures that will be implemented by the local self-government in 2011 in terms of solving the problem of unowned dogs. The strategy for solving the problem of stray dogs and cats in the territory of the city of Belgrade is a document that defines the principles, goals and measures that will be implemented by the City of Belgrade in terms of solving the problem of stray dogs. The strategy is monitored and supervised by the Secretariat for Communal Housing Affairs, while the direct executor is VUVB. Operational measures in this area are adopted by the Commission for the implementation of the strategy, which was formed by the conclusion of the mayor. The aforementioned strategy was adopted at the Assembly of the City of Belgrade held on September 21, 2011, based on Article 54, Paragraph 2 of the Law on Animal Welfare, Article 20 of the Law on Local Self-Government, and Articles 25 and 31 of the Statute of the City of Belgrade.

The development of this strategy for the City of Belgrade and its implementation was guided by the principle of humanity, combining the no kill strategy and the CNR method “catch-neuter-release”, with a special focus on health protection people and animals, and applying measures of education, control and sanctions against irresponsible owners whose carelessness and disregard for positive legal regulations and moral principles directly cause an increase in the number of abandoned dogs.

Taking into account the gravity of the problem as well as the fact that solving it directly manipulates animals that are able to feel suffering, fear, stress and pain, it was necessary to objectively look at all the relevant causes of the problem, but also to define measures and methods that will be the most adequate, sustainable and humane way in a time period of 5 to 10 years, the intensive implementation of the Strategy will give results that will:

1. Reduce the population of abandoned animals to an acceptable level, without disturbing the biological balance, the violation of which can cause the growth of the population of other animal species (cats, harmful rodents, etc.);
2. Maintaining the population within the number that ensures biological balance;
3. Providing captured abandoned animals with adequate veterinary assistance, including depriving them of their lives in a humane way, when necessary.

7.1 GENERAL GOALS OF THE STRATEGY

During the development of the strategy, the objectives were first determined, which were the starting point for its development. At the sessions that followed, the general goals of the "Strategy for dealing with stray dogs in the territory of the City of Belgrade" were adopted and they are:

1. Reduction of the population of stray dogs and cats;
2. Control of the existing population of dogs and cats;
3. Protection of human and animal health
4. Promotion of responsible animal ownership and welfare
5. Compliance with legal and by-laws
6. Prescribing measures to stimulate sterilization and marking of owner's animals for population control
7. Construction of new capacities for housing abandoned animals In order to achieve better operability; specific objectives of the strategy were defined along with them.

7.2 SPECIFIC OBJECTIVES OF THE STRATEGY

The specific objectives of the strategy were as follows:

1. Registration of all owned dogs and cats in the territory of the city of Belgrade, registration of all abandoned dogs and cats, as well as the formation of a unique database within the database of the Veterinary Administration (vet up).
2. Introduction to the legal status of guardians of street animals

3. Introduction and collection of local communal tax for keeping pets
4. Construction of ecological zones or parks for dogs
5. Development of an action plan, i.e. a control program to reduce the population of stray dogs and cats.

7.3 PROBLEMS IN IMPLEMENTING THE STRATEGY

The problems encountered in the implementation of the Strategy, in addition to the harsh economic conditions, are: non-compliance with applicable laws, lack of conditions for the application of existing legal solutions, but also the fact that certain legal solutions are not good enough and need to be corrected. This applies in particular to:

1. Inconsistency of legal regulations, namely the Law on Veterinary Medicine and the Law on Animal Welfare
2. Centralization of control of both above-mentioned laws in the veterinary inspection
3. The absence of an adequate regulation on the marking of dogs and cats, as well as the lack of adequate control and sanctions against irresponsible owners
4. Inadequately prescribed measures, rights and powers of the control agents (veterinary inspection, communal inspection, communal police)
5. Non-recognition through acts of the existence of a street population of abandoned animals and therefore the inability to adequately record, monitor the epizootic situation as well as adoption.

This also prevented the connection of stray dogs and cats to the single database of the Veterinary Administration.

6. Non-recognition of the existence of individuals who want to take care of abandoned animals (guardians), which makes it impossible to keep records of those persons and the number and structure of the animals they take care of.
7. Non-hyphenation of the problem and the term “hoarding”, which represents an almost unsolvable problem, especially in urban areas.
8. The general disinterest of pet owners both in terms of the health care of their own pets (vaccination, chipping, deworming, prevention of unwanted mating), and in terms of environmental protection. The explanation of this phenomenon lies primarily in the ineffective control of the competent authorities, in the lack of authority and in the excessive procedure that is required to adequately punish irresponsible owners.

7.4 MONITORING THE EFFECTS OF IMPLEMENTING THE STRATEGY

In order to assess the exact state of affairs and prepare this Strategy, the Project "Determining the population size and category of stray dogs in the territory of the city of Belgrade in urban and suburban areas" was carried out. Based on data from the Project from 2006, as well as data from the Veterinary Institution "Veterina Beograd", and before the establishment of the "Strategy for solving the problem of stray dogs in the territory of Belgrade" in the 10 central city municipalities, an estimated number of 4,400 to 4,600 dogs with predicted degree of statistical error from 5% to 10%.

By applying the logical matrix of the actual number of street dogs in 2010, it was determined that their number was 8,500 individuals in 10 Central City Municipalities. It could also be concluded that the estimated raw number of 2954 dogs according to the logical matrix, on an annual basis, could produce more than 2250 offspring in the F1 generation alone. With the application and implementation of the "Strategy for Solving the Problem of Stray Dogs in the Territory of Belgrade" in the period of 2009 and 2010, followed by a controlled, precise counting of dogs, using the field method, in the territory of the 10 central city municipalities, the number of 8,500 dogs was determined, with the application euthanasia only and exclusively in medically indicated cases.

7.5 RESULTS OF STRATEGY APPLICATION

Analyzing the obtained data, it is unambiguously concluded that:

1. With the implementation of the Strategy for solving the problem of stray dogs in the territory of Belgrade, the population of abandoned animals on the streets was stabilized with a tendency to decrease with the application of the CNR system;
2. By applying the NO KILL (no euthanasia) component of the CNR system, the effect of the increase in the dog population as part of the active implementation of mass sterilization in 2010 resulted in a 50% smaller increase in abandoned dogs;
3. The influx of dogs by irresponsible owners, based on the assessment, constitutes 2/3 of the total number of increments from point 2;
4. In addition to the measures implemented by the Secretariat for Communal and Housing Affairs and the "Veterina Beograd" Veterinary Institution, it is necessary to implement a clear penal policy towards irresponsible owners as well as other measures defined by the Strategy for solving the problem of stray dogs in the territory of Belgrade;

5. It is necessary to increase capacities with the aim of more active performance of animal hygiene activities in the area of other city municipalities;

In addition, based on the results obtained so far, it can be unambiguously concluded that:

1. With the implementation of the Strategy for solving the problem of stray dogs in the territory of Belgrade, the population of abandoned animals on the streets was stabilized with a tendency to decrease with the application of the CNR system;
2. By applying the NO KILL (no euthanasia) component of the CNR system, the effect of the increase in the dog population as part of the active implementation of mass sterilization in 2010 resulted in a 50% smaller increase in abandoned dogs;
3. The influx of dogs by irresponsible owners, based on an estimate, accounts for 2/3 of the total number of abandoned dogs;
4. In addition to the measures implemented by the Secretariat for Communal and Housing Affairs and the "Veterina Beograd" Veterinary Institution, it is necessary to implement a clear penal policy towards irresponsible owners as well as other measures defined by the Strategy for solving the problem of stray dogs in the territory of Belgrade;
5. It is necessary to increase capacities with the aim of more active performance of animal hygiene activities in the area of other city municipalities;

7.6 IMPACTS OF THE STRATEGY ON THE CONTAMINATION OF PUBLIC PLACES

At the same time as the adoption of the Strategy, regular parasitological monitoring of public places and parks in Belgrade continued. By the way, he has been working since 1993 [3,5,6,7]. The average contamination of the parks in 2010 was 39.06%, and in 2020 it will drop to 26.68%. During these ten years, the average percentage of established eggs of Toxocara canis was 29.68%, Ancylostomidae sp. 27.18%, Dipyllidium caninum 26.56%, Strongyloides stercoralis 7.81%, Toxascaris leonina 6.97%, Taenia sp. 6.25% and Trichuris vulpis 4.68%. Giardia duodenalis was found in 15.62%, Amoeba sp. in 11.06%, Isospora spp. in 9.36% and Cryptosporidium sp. in 3.37%. A visible reduction in the degree of contamination of public places was observed in the mentioned period. Despite the visible improvement, from an epidemiological point of view, the research results indicate a real possibility of human infections in the areas of most city parks.

8 CONCLUSIONS

Public interest in the welfare of animals is growing and is increasingly present in the world, as well as in our society. This trend inspires numerous debates and discussions about animal welfare as well as ways and problems that arise when solving the problem of abandoned animals. Factual and scientific knowledge in this area must support and inform ethical decisions, and especially the need to understand the affective states of animals (the problem of interaction with people) and their needs in relation to the environment in which they move and find themselves. Animal welfare is a course that should guide us in applying methods to solve the problem of abandoned animals. The positions that need to be defended, which concern the welfare of animals, require scientific knowledge about the biology of animals, in order to enable the closest determination of their physiological, health and psychological needs, as well as to better solve the problems and issues of their impact on the environment and people's health. The bearers of solutions in this area should first of all be veterinarians, who will bring programs and give expert opinions, and then all state and public officials, who can contribute to a successful solution to this problem through their work and advocacy.

With this approach, our society ranks among developed countries, which approach the solution to the problem of abandoned animals on a scientific basis, and the quality of the Strategy itself is best expressed by the fact that similar guidelines are given in the European Parliament Written Declaration pursuant to Rule 123 of the Rules of Procedure on dog population management in the European Union No 0026/2011 of 06.10.2011 (6) (adopted almost a month after the adoption of our Strategy). This Strategy has also shown positive results in reducing the pollution of public places by dog parasites because it contributes to the preservation of human health.

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SOBRE O ORGANIZADOR

EDUARDO EUGENIO SPERS realizou pós-doutorado na Wageningen University (WUR), Holanda, e especialização no IGIA, França. Possui doutorado em Administração pela Universidade de São Paulo (USP). Foi Professor do Programa de Mestrado e Doutorado em Administração e do Mestrado Profissional em Comportamento do Consumidor da ESPM. Líder do tema Teoria, Epistemologia e Métodos de Pesquisa em Marketing na Associação Nacional de Pós-Graduação e Pesquisa em Administração (ANPAD). Participou de diversos projetos de consultoria e pesquisa coordenados pelo PENSA e Markestrat. É Professor Titular no Departamento de Economia, Administração e Sociologia, docente do Mestrado em Administração e Coordenador do Grupo de Extensão MarkEsalq no campus da USP/Esalq. Proferiu palestras em diversos eventos acadêmicos e profissionais, com diversos artigos publicados em periódicos nacionais e internacionais, livros e capítulos de livros sobre agronegócios, com foco no marketing e no comportamento do produtor rural e do consumidor de alimentos.

ÍNDICE REMISSIVO

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