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Invited lecture

THE MOST COMMON HEALTH DISTURBANCES DETECTED IN WILD BOARS IN ENCLOSED HUNTING GROUNDS IN VOJVODINA PROVINCE

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Abstract

The control of health status of wild boar population is quite demanding and it is not easy to achieve. Also, often is not possible entirely to perform a complete diagnostic examination in wild boars in each evaluated case. The aim of this research was to evaluate the most common health disturbances detected in wild boars in enclosed hunting grounds in Vojvodina Province. The material for this research included enclosed hunting grounds, where clinical signs of health disorders and dead of different categories of wild boars were recorded. The following research methods were applied: epidemiological investigation, clinical examination of live and gross pathological examination of dead and/or shot diseased wild boars. The clinical examination was performed from the safe distance at the feeding place. In the laboratory, the applied research methods included: bacteriological testing, virusological testing (ELISA test, HI test and RT-PCR) and parasitological examination. On the basis of the achieved results it may be concluded that wild boars could be source of different endoparasites species. By gross pathological examination it was discovered that in the largest number of animals the health problems were mainly connected to the parasitic infestations and bacterial infections of digestive and respiratory organs.

Keywords: wild boars, enclosed hunting grounds, Vojvodina Province

Introduction

Wild boar (*Sus scrofa scrofa*) numbers have dramatically increased over the past 60 years and the species also shows a more widespread distribution (Artois et al., 2001; Sedlak et al., 2008; Wu et al., 2011), which not only means a larger number of hosts available for the transmission of disease, but also a higher contact rate between hosts (Ruiz-Fons et al., 2008). The population of wild boar in 15 member states of European Union (EU) has been roughly estimated between 800,000 and 1 milion heads, but its density varies from country to country (Laddomada, 2000). Increasing food availability and climatic change provide optimal conditions for a rapid wild boar multiplication and expansion (Wu et al., 2011). According to available data of the Veterinary directorate of the Ministry of Agriculture and Environmental protection, in the Republic of Serbia, the population of wild boars was aproximatelly estimated on 30.000,00 heads and the density of the wild boar population ranges from a minimum of 0.2/km^2 to over 20/km^2. In Serbia, there are about 300 hunting grounds with wild boars. Hunting grounds are managed by two public enterprises, also two hunting association, four National parks in wich hunting is allowed and 5 hunting grounds are managed by Ministry of Defence. In Vojvodina Province, there is one public enterprise „Vojvodinašume" with 17 hunting grounds, one National park Fruška gora, one private hunting ground and 86 hunting associations.

Wild boar pathogens are highly relevant not only for the livestock industry but also for wildlife conservation and for the hunting industry (Došen et al., 2013; Laaksonene and Paulsen, 2015; Prodanov-Radulović et al., 2014a). Knowledge of diseases circulating in wildlife populations can be

important not only for conservation and livestock production but also for public health (Boadella et al., 2012; Meng et al., 2009). Because several million wild boars are harvested and consumed yearly in Europe, wild boar meat and derivates are a likely source of human infections (Boadella et al., 2012).

Wildlife is a reservoir for several economically important diseases and epizootiologic surveys are needed, especially in large wild boar populations (Garcia-González et al., 2013). Many diseases may cause external symptoms and abnormal behaviour in game animals. They can also diminish the value of the end products obtained from game. In the most of the cases, the assessment of game animal health is based on medical history of the game and, after shoting, observations made of the carcass and viscera (Laaaksonen and Paulsen, 2015; Prodanov et al., 2009a; Prodanov-Radulović et al., 2013a). Migrating and roaming animals can carry pathogens over long distances (Laaaksonen and Paulsen, 2015). The parallel increase of outdoor piggeries has led to a higher risk of contacts, and thus of disease transmission, between wild boars and domestic pigs. Because pigs and wild boars belong to the same species, they share the same pathogens (Prodanov et al., 2009a; Prodanov et al., 2009b; Wu et al., 2011). The overabundance of wildlife, recognized as a relevant risk factor for disease transmission between wildlife and domestic animals, compromises the health surveillance programs carried out both populations (Frölich et al., 2002; Ruiz-Fons et al., 2008). Hunting and consumption of wild boar meat enables direct contact of humans and wild pigs, providing ideal conditions for pathogen transmission from wild to domestic pigs and humans. It should be taken into consideration that domestic animals and humans usually have never been exposed to pathogens common for wild pigs, and thus are highly susceptible to infection (Ruiz-Fons et al., 2008). Hunters have a greater than average risk of encountering various pathogens communicable from animals to people. The ways of handling the carcass, meat, offal and hides have an effect on this risk (Laaaksonen and Paulsen, 2015).

Animal health surveillance is routinely applied to domestic animals, but limited data exist on the prevalence and distribution of infectious agents of wild boars in Vojvodina Province. Also, often is not possible entirely to perform a complete diagnostic examination in wild boars in each evaluated case (Petrović et al., 2012, Prodanov-Radulović et al., 2013a; Prodanov-Radulović et al., 2013b). In Vojvodina Province a certain number of wild boars is controlled and reared in an enclosed hunting ground while the number of free-ranging population is mainly unknown (Prodanov et al., 2009b). One of the characteristics of outdoor swine production in some regions of Vojvodina is raising free-roaming domestic pigs, where they share forest habitat with wild boar population. It can be assumed that direct contacts between wild boars and domestic pigs kept in outdoor farms occur occasionally (Došen et al., 2013; Prodanov-Radulović et al., 2011; Prodanov-Radulović et al., 2014a).

In some regions, especially near the river banks, domestic pigs are kept outdoors on the pasture, which provides favourable conditions for infection transmission. Domestic pigs move freely in the woods, thus getting in contact with wild boars. However, after summer pasture, domestic pigs are returning into the pens. It is especially important that owners of the free-roaming animals in the same time have backyard pigs (Prodanov et al., 2009b). In areas in which traditionally raising free-roaming domestic pigs has been introduced in the woods, hybridization with the wild boars has led to crossbreeding, production which is often referred to as a feral pig or feral hog (Ruiz-Fons et al., 2008). In our research during the epizootiological and clinical examination, we discovered the existence of this type of animal hybrids in the backyards of the owners who practice extensive grazing (Prodanov et al., 2009b).

The objective of our study was to evaluate the most common health disturbances detected in wild boars in enclosed hunting grounds in Vojvodina Province, focusing on detected diseases that are epidemiologically and economically important to the health of both wild boar and domestic swine populations.

Material and Methods

The material for this research comprises two different sources with the aim to perform health control wild boars population in enclosed hunting grounds in Vojvodina Province. As a part of health control program of wild boars, regularly shot by hunters, the examination of the trunci and internal organs deriving from wild boars was carried out. The detailed gross pathological examination, according to the specially adopted protocol, with an aim to not interfere with regular hunting procedure, and taking the samples for laboratory examination, was done. In order to check the wild boars in which the hunters noticed some signs of abnormal behaviour and/or signs of diseases, the gross pathological examination of carcasses of dead or diseased animals shot by hunters and laboratory testing of their organs and tissue samples was performed. The following research methods were applied: epidemiological evaluation, clinical examination of live and gross pathological examination of dead wild boars, standard laboratory testing for detection the presence of aerobic and anaerobic bacteria in tissue samples (mediastinal and mesenterial lympho nodes, lungs, heart, liver, spleen, kidney) deriving from dead wild boars, patohistological examination (lungs) and serology testing (sera samples).

Isolation of bacteria from tissue samples deriving from dead pigs was performed by standard aerobic and microaerophilic cultivation. Microscopic examination determined whether the isolated bacteria were Gram positive or not and whether it is a coccoid or rod-like organisms. The determination was carried out by determining the biochemical characteristics of the isolated bacteria. Beside this, each animal carcass was thoroughly analysed by gross pathology examination for the presence of helminths. Lung, digestive tract, liver, gall-bladder and renal pelvis were examined with routine techniques for the detection of helminth parasites. A parasitological examination was carried out with fecal material extracted from the rectum of each animal after necropsy (zinc sulphate flotation, sedimentation and McMaster's method). In cooperation with the hunting societies and local veterinary service gathering of sera samples of hunted wild boars was organized. The serology testing included classical swine fever (indirect immunoenzyme test kit: HerdChek CSFVAb, IDEXX Laboratories, USA) and porcine parvovirus (haemagglutination inhibition test).

Results and Discussion

Wild boars diseases caused by bacteria

On the several examined hunting grounds, the case history data revealed the problem in piglets category with clinical signs of growth retardation. The piglets were reluctant to move, fatigued, easy to catch and a large number of dead piglets were discovered. As a part of health control program, clinically diseased wild boars (animals showing staggering gait, with long bristling hair and arched back) were shot by hunters. The gross pathological examination revealed changes dominantly in the respiratory tract: severe necrotizing pleuropneumonia and the presence of multiple abscesses in the lung tissue (*Pneumonia apostemosa disseminata*). In few animals, purple to gray areas of consolidation of lung tissue were detected (*Pneumonia fibrinosa in statu hepatisatiois rubrae et griseae*). Macroscopically, the lung lobes were very similar to the hepato or pancreatic tissues. In addition, the trachea and bronchi were filled with a foamy exsudate mixed with small number of lung worms in the respiratory pathways. By standard bacteriological testing on tissue samples (lungs, mediastinal lymph nodes) *Pasteurella haemolytica, Streptoccocus alfa haemolyticus, Streptococcus beta haemolyticus* and *Actinobacillus pleuropneumoniae* were detected.

In various game animal species, the bacteria from the genus *Pasteurella* can cause epidemics with high mortality rate (Laaaksonen and Paulsen, 2015). The bacteria from the genus *Pasteurella is* probably the most frequent and damaging invader in the lung i.e. tipically secondary invader and was never isolated in the bronchial tree of healthy pigs. Even the most pathogenic strains are not capable of infecting a healthy lung, unlike *A. pleuropneumoniae* (Le Potier et al., 2006). It is consider that the outbreak of the disease in wild boars requires stressful and predisposing factors, such as poor state of nutrition, overexertion, overdensity of population, unfavourable weather conditions and great number of parasites. Common clinical symptoms in wild boars include hanging of head and severe functional disorder of respiratory organs (Laaaksonen and Paulsen, 2015; Prodanov-Radulović et al., 2013b).

Actinobacillus pleuropneumoniae is considered an obligate parasite of the porcine respiratory tract and there are no other natural hosts. Transmission occurs via aerosols or direct contact between pigs. The clinical and pathologic outcome of infection depends on serovar and virulence factors, but also on age, immunity, hygiene, infectious pressure, breed, and stress factors (Reiner et al., 2010). Pleuropneumonia caused by *A. pleuropneumoniae* is one of the important bacterial diseases of the respiratory tract of the pig and occurs in most pig-keeping countries (Boadella et al., 2012). Subclinically and chronically infected pigs may enter a permanent carrier state, harbouring *A. pleuropneumoniae* in sequestra or well-encapsulated abscesses in the lung and in tonsillar crypts (Le Potier et al., 2006). Survivors of acute infections become carriers, and the infectious agent is located mainly in nerotic lung lesions and/or in the tonsils, less frequently in the nasal cavity (Boadella et al., 2012). Reiner et al. (2010) discovered that the overall prevalence of wild boars that were PCR-positive for *A. pleuropneumoniae* DNA was 35.8%. *Actinobacillus pleuropneumoniae* DNA was amplified from tonsils of 34.8% and from lungs of 6.4% of wild boars. The discrepancy between *A. pleuropneumoniae* loads in lungs and tonsils likely demonstrates the higher colonization of tonsil tissue with *A. pleuropneumoniae* in wild boars, although it cannot be excluded that lungs were categorized as false negatives. Prevalence of *A. pleuropneumoniae* increased with age and body weight. Higher prevalences in tonsils without gross pathologic signs of pleuropneumoniae suggest colonization of most of these animals by non-pathogenic or low-pathogenicity serotypes (Reiner et al., 2010).

In Europe, most attention has been devoted to diseases that are under official surveillance and control in either pigs, wild boar or both, while other infections have received comparatively less effort. Monitoring wildlife diseases faces a number of wildlife-specific constaints, including sampling difficulties regarding proper sample and site stratification, consistent sampling of the same sites, and limitations of the diagnostic test available for wildlife (Boadella et al., 2012). It should be stressed that overdense regional game populations are a predisposing factor for the disease (Laaaksonen and Paulsen, 2015).

In only few examined enclosed hunting grounds, by clinical examination of wild boars during the feeding, the clinical signs (greyish to brownish diarrhea) of the enteric infection were observed. Applying bacteriological testing on tissue samples (kidney, liver, spleen, mesenterial lympho nodes) derived from diseased shot and dead wild boars the presence of *Escherichia coli* and *Escherichia coli haemolytica* was detected. Most common gross pathology findings included moderate signs of gastric and intestinal infection and enlarged mesenterial lymph nodes.

Escherichia coli bacteria cause a group of enteric diseases mostly found in young wild boars (Laaaksonen and Paulsen, 2015). Disease outbreak usually requires predisposing factors, depending on the virulence of bacterium. Starvation and poor condition of mothers/dams set the scene for an outbreak of the disease. Infection pressure is also increased when the number of diseased animals is high and the population is dense (Laaaksonen and Paulsen, 2015; Prodanov-Radulović et al., 2013a). In the treatment, usually the same antibiotics are used in the treatment of bacterial diseases of domestic pigs and wild boars. Bacteria have a genetic ability to mutate and develop strains that

are resistant to antibiotics. This, together with poorly planned treatment or mass uncontrolled use of antibiotics, may cause great problems in the health care of humans and animals (Došen et al., 2014). In the control, important precautions include game animal feeding ground hygiene and prevention of contacts between game and production animals (Laaaksonen and Paulsen, 2015).

Wild boar diseases caused by parasites

By gross pathology examination, the adult forms of several gastrointestinal parasites were discovered: *Ascaris suum, Macracanthorhinhus hirudinaceus, Trichuris suis.* However, no gross pathology lesions were detected in the gastrointestinal tract of examined wild boars. Applying parasitological control of the intestinal content and/or faecal material extracted from the rectum, the presence of eggs from several parasites was discovered: *Trichuris suis, Oesophagostomum sp.* and *Hyostrongylus sp*. Also, in most of the examined cases, the presence of Protozoa of genus *Eimeria* (*Coccidia*) was detected. Parasites, and changes caused by them, are the most common findings that a hunter confronts in game handling. It is important to distinguish between a parasitic infection, which practically all animals have, and a disease caused by parasites. The manifestation of disease is often directly comparable to the severity of parasitic infection **(**Laaaksonen and Paulsen, 2015; Prodanov-Radulović et al., 2011).

The parasite from genus *Coccidia* reproduces in the intestines and damages the intestinal lining, causing diarrhea and intestinal dysfunction of host animals and produce egg-like oocysts to their feces. The infection is transmitted to another animal via feces-contaminated food or water. In dense populations, the transmission of the parasite increases and infection pressure grows. Consequently, coccidian may become a significant cause of mortality in young animals. In the prevention, correct location and hygiene of game feeding grounds is important (Laaaksonen and Paulsen, 2015). Roundworms (*Trichostrongylidae, Trichuroidea, Strongylidae* and *Ascaroidea*) that parasitize in the gastrointestinal tract are frequently found in wild boars (Prodanov-Radulović et al., 2013a). An adult parasite inhabiting the stomach or intestines of a host animal produces eggs that are passed to the environment in feces. In general, parasites of the gastrointestinal tract do not cause problems under normal conditions, and their spread is self-limiting. However, these parasites are significant in dense animal populations, as well as when starvation occurs. In that case, diseases may be caused especially by large roundworms (*Ascaroidea*), they can cause weakening of the animal and significant mortalities. In addition, animals with a parasitic infection can present a weight loss, wasting, swollen abdomen, dry and dull hair and diarrhea (Laaaksonen and Paulsen, 2015).

In most of the shot healthy, diseased or dead found wild boars originated from different enclosed hunting areas the presence of lung worms was established. Clinically, the case history data revealed the problem in piglets category (signs of growth retardation). The piglets were described as reluctant to move, fatigued, easy to catch. In several examined hunting grounds, by clinical examination clinical signs of respiratory infection in young wild boars were detected: dispnoea and intensive coughing („thumping"). The wild boars were emaciated and slow gait, with shrunken eyes and tough dry hair, and lagging behind the pack were noticed. As part of health control program of clinically diseased wild boars shot by hunters, gross pathological examination of trunci and internal organs deriving from shot wild boars was performed. In all examined cases, the gross pathology examination revealed changes dominantly in the respiratory tract: purulent nasal discharge, effervescent content in bronchi and bronchioles, mixed with a large number of lung worms, which were like mucoid plugs filling the respiratory pathways (*Metastrongylosis pulmonum summ*). All lobes of the lungs were diffusely swollen, edematous and reddened with marginal emphysema and consolidation. A large amount of clear, foamy fluid and numerous slender, white nematodes 4-7 cm long were visible in the trachea and bronchial trees. In several cases, pathomorphologically the presence of numerous abscesses (*Pneumonia apostematosa disseminata*) in lung tissue were detected. In the cases when macroscopically changes on the lung tissue were noticed, the pathohystological examination were performed and in two examined shot wild boars *Pneumonia*

interstitiais was diagnosed. By parasitological examination the presence of lung worms (*Metastrongylus spp*.) in the trachea, bronchi and in posteroventral parts of the diaphragmatic lung lobes were detected (*Pneumonia verminosa).*

Lungworms are often encountered as highly prevalent helminthes in wild boars (Prodanov-Radulović et al., 2011; Senlik et al., 2011). In Europe, these parasites have a high prevalence, affecting more than 80% of pigs created in extensive system and considered one of the main causes of respiratory changes of these animals (Da Silva et al., 2013). This result might be explained by the wide geographical distribution of different earthworm species, which form part of the diet of wild boars and act as intermediate hosts for these parasites (Senlik et al., 2011). An adult parasite dwells in the bronchial tubes of wild boars, where it produces eggs. The eggs are coughed up to the throat and travel via the pharynx to the intestines. In the intestines, the eggs develop into larvae and are passed in feces to the ground. New animals are infected after ingestion of food that contain larvae. Inside the new host, the larvae penetrate the intestinal wall and migrate via lymphatic vessels to the lungs, thus completing the parasitic life cycle (Laaaksonen and Paulsen, 2015; Prodanov-Radulović et al., 2011). Mild infections are often asymptomatic. Severe infections cause caught and inflammation of the lungs, the symptoms of which may include deterioration of general condition, slow growth, weight loss and mortalities. By gross pathological examination, adult parasites can be seen in the bronchial tubes. The scars left by them are greenish areas of 0.5 to 2 cm in size in the lungs (Laaaksonen and Paulsen, 2015). The verminous processes are mainly located dorsocaudally in the lung (Prodanov-Radulović et al., 2013b).

Lung parasites of the genus *Metastrongylus* are considered one of the most important selective factors acting on wild boar population, increasing the mortality of weaker young and adult animals because they may cause dyspnea, bronchopneumonia, and permanent weight loss in addition to inflicting tissue damages which allow opportunistic infections of viruses and bacteria (Da Silva and Muller, 2013). Young wild boars are thought to ingest a higher number of earthworms than adults and therefore may have a higher level of parasitism (Garcia-González et al., 2013; Järvis et al., 2007). In Europe, these parasites have high prevalence, affecting more than 80% of pigs created in extensive system and considered one of the main causes of respiratory changes of these animals (Da Silva and Muller, 2013; Yoon et al., 2010). Despite the limited number of wild boars examined, our study suggests these species are common and enzootic in wild boars in Vojvodina region (Prodanov-Radulović et al., 2013a; Prodanov-Radulović et al., 2013b). The reason for the high prevalence of lungworms may be the density of game population, which often is the natural explanation of the spread of a parasite transmitted from animal to animal **(**Laaaksonen and Paulsen, 2015; Järvis et al., 2007). In control, infection pressure can be diminished by preventing the development of dense game populations and maintaining good game feeding ground hygiene (Laaaksonen and Paulsen, 2015). The uncontrolled use of anthihelmintics can lead to an excessive selection of resistant parasites, which may cause an increase in the infection intensity (Da Silva and Muller, 2013).

Sporadically, by gross patology examination of shot wild boars, the presence of parasitic cysts in the abdominal cavity were detected. Tapeworms (*Taenia hydatigena*) is a ubiquitous parasite, the definitive hosts of the adult parasite are carnivores such as wolf, dog, lynx and fox. The parasites intermediate hosts are herbivores and wild boars, which get the parasites eggs to their intestines through food. The larvae burrow through the intestinal wall and form cysts in the body of intermediate host (*Cysticercus tenuicollis***)**. Each cysts contains one infectious larva. When the cyst-bearing animal is eaten by a carnivore, the parasites life cycle is completed. The pearly gray, liquid-filled cysts of the T. hydatigena tapeworm, 1.5 to 10 cm in diameter, are most commonly found in the omentum, liver or peritoneum of wild boars. Single, smaller cysts go easily unnoticed, since the parasite cysts, as far as is known, do not cause symptoms to the intermediate host. In order to break a cycle, an infected animal's raw meat or organs should not be given to dogs or wild animals (Laaaksonen and Paulsen, 2015)

The other detected parasitic agent in examined wild boars is cysts of a tapeworm, *Echinococcus granulosus*. The definitive hosts of *E. granulosus* are canines, often wolves, whose intestines are inhabited by adult parasites. The eggs produced by the parasite are spread to the environment through the host animals feces, and further via food to the intermediate host. Inside the intermediate host, the parasite forms cysts that contain a large number of infectious larvae. When the animal and cysts are ingested by carnivores, the parasites life cycle is completed (Rojo-Vazquez et al., 2011). Typical cysts (hydatid cyst) are commonly found in the liver of the wild boars. Their size varies, depending on the duration of the infection. The cysts are often pearly grey colour and contain clear liquid with thousands of small, infectious larval forms of the parasite. The number of cysts may vary from a single one to over a hundred cysts. An animal suffering from severe infection and large cysts in abdominal cavity or lungs is more easily killed by carnivores. This assists in the completion of the parasites cycle. *E.granulosus* infection can be contracted by humans, who ten act as intermediate hosts and the infection causes a so called hydatid disease (hydatidosis) (Laaaksonen and Paulsen, 2015).

Mycotoxicoses in wild boars

In two examined enclosed hunting areas, the problem of diarrhoea, slow growth and mortality in piglets was discovered. The clinical examination was performed from the safe distance at the feeding place. The signs of weakness and growth retardation, staggering gait, trace of fecal content on the hind body parts and on the ground were found. In the feed control a significant quantity of moldy corn was discovered. Having in mind all the facts, the potential problem of mycotoxicosis was suggested.

Different fungal species (*Fusarium, Aspergillus, Penicillium genera)* produce mycotoxins in food and cause intoxication to those animals that eat the contaminated food. On entering the body, the toxins possibly produced by fungi may cause a group of different symptoms that are often difficult to recognize (Prodanov-Radulović et al., 2014b). Mycotoxins can get to wild animal food from grass of fodder made from grass, from silage and grain feed (Laaaksonen and Paulsen, 2015). Symptoms caused by mycotoxins in animals depend on the toxin and the ingested dosage. Clinical symptoms vary from organ-destroying acute intoxications to chronic states of intoxication that may include reduced appetite, diarhoea, weight loss and reproductive disturbances. Diagnosis is difficult to make as the mycotoxin content is very small and several toxins can be found in the same sample (Prodanov-Radulović et al., 2014b). Fungal intoxication has rarely been reported in game animals, perhaps due to difficulty of reaching a diagnosis. In nature, the occurrence of mycotoxins cannot be controlled. However, the entrance of mycotoxins into the nourishment of game animals can be avoided with careful hygiene of game animal feeding grounds, using only feed that would be acceptable for production animals, do not offer feed from the ground but from a feeding device that prevents the feed from getting wet (Laaaksonen and Paulsen, 2015).

Wild boar diseases caused by viruses

In cooperation with the hunting societies and local veterinary service gathering of sera samples of hunted wild boars was organized. Serological examination in year 2009 on the presence of specific antibodies against CSFV (ELISA test) comprised only 259 blood samples obtained from wild boars in the hunting area of Vojvodina region and it revealed negative result. In year 2010 the serological control of CSFV antibodies in wild boars population included significantly larger number of animals i.e. in total 471 tissue samples and 455 blood samples were examined. From examined blood samples, in 36 positive results i.e. the presence of specific antibodies against CSFV was detected. However, applying reverse transcription-polymerase chain reaction (RT-PCR) analysis the presence of viral genome was not established in tissue samples deriving from shot wild boars. The serological control of the CSFV presence in wild boars population in Vojvodina region was even more intensified during years 2011-2012. In total 2038 samples were examined: 996 sera samples

and 1042 tissue samples (spleen, lymph node, and kidney). Once again, in 33 sera samples the presence of CSFV specific antibodies was detected. Clinically, no abnormal mortality has been reported in the analyzed districts of Vojvodina region (Prodanov-Radulović et al., 2013a; Prodanov-Radulović et al., 2014a). By additional epidemiological evaluation, it was discovered that some of the examined sera samples from certain hunting grounds that tested positive were a consequence of previous vaccination against CSFV in the past, with modified live (China strain) vaccine. Although prohibited from 1983 in Serbia, CSFV vaccination of wild boars may have been applied for a while after vaccine ban (Prodanov et al., 2009b). Therefore, we cannot exclude the possibility that vaccinated wild boars may have been sampled and detected as positive in the survey. This could explain the presence of antibodies against CSFV in some of examined sera samples. In research conducted in 2013, applying RT-PCR analysis the presence of CSFV genome was not established in tissues samples deriving from shot wild boars in Vojvodina (Prodanov-Radulović et al., 2014a). However, the results of the epizootiological questionnaire indicated that CSFV may be present in hunting grounds in the region of Danube River, implying that the wild boars population represents also a source of infection with CSFV (Prodanov et al., 2009b).

Classical swine fever (CSF) is a viral disease caused by a member of *Flaviviridae* family, genus *Pestivirus* and of great economic concern for the pig farming industry (Artois et al., 2002; Rossi et al., 2005). The disease in the wild boar population was diagnosed and/or serologically confirmed in several Central and Eastern European countries (Artois et al., 2002; Montagnaro et al., 2010; Prodanov et al., 2009b; Roic et al., 2012; Rossi et al., 2005; Vengust et al., 2006). In some European countries, CSFV has been reintroduced periodically into domestic pigs via contact with infected wild boars (Le Potier et al. 2006; Rossi et al., 2005). Moreover, epidemiological links between CSFV infections in wild boars and domestic pigs have been repeatedly reported, mainly in Germany (Ruiz-Fons et al., 2008). At present, CSF monitoring program in Serbia is primarily focused on the serological investigations of blood samples and control of tissue samples by RT-PCR from hunted wild boar. Sampling is performed randomly based on the density of the wild boar population in different regions (Prodanov –Radulović et al., 2014a). The inveterate tradition to keep domestic pigs at free range and the consequent contacts with the wild boars are considered the major cause of outbreaks of CSF, which seems to facilitate disease persistence (Laddomada, 2000; Rossi et al., 2005).

In one enclosed hunting ground, according to the history data and clinical signs detected in wild boars (a small number of newborn piglets, stillborn and mummified piglets in the litters), the problem of PPV infection was suggested. However, the clinical examination was feasible only in a certain number of wild boars located in specially separated, fenced area. During the visit of hunting area it was noticed that the fence was not entirely surrounding the area and there were parts without fence. Having in mind migratory characteristics of population, this could facilitate contact with domestic pigs located in forest habitat. Applying serological examination (HI test) of blood samples, antibodies against PPV were widely distributed among the wild boar population in Vojvodina province: 148 (49.33%) of the 300 examined samples tested PPV positive. The highest prevalence of seropositive animals was associated with the hunting areas in Bačka and Srem districts. We believe that this is connected with the tradition of keeping domestic pigs in woods (especially in Srem district), thus increasing possible contact and transmission of diseases between wild boars and domestic swine (Prodanov et al., 2009b; Prodanov-Radulović et al., 2014a). The high prevalence of PPV antibody suggests this virus is endemic in our wild boar populations. In Europe, PPV is highly prevalent in wild boars, with an incidence ranging from 14 to 57 % (Ruiz-Fons et al. 2008; Vengust et al., 2006), except Italy, where low prevalence of antibody to PPV was reported (Montagnaro et al., 2010).

Conclusion

On the basis of the achieved results we can conclude that wild boars could be source of different endoparasites species. The gross pathological examination discovered that in the largest number of animals the health problems were mainly connected to the parasitic infestations and bacterial infections of digestive and respiratory organs. Discovered parasitic infestations in the evaluated wild boars are economically significant because of retardation in the growth and weigh gain. The obtained serological results suggest that wild boars have direct or indirect contact with domestic pigs, which facilitate transmission of pathogens. Avoiding close contact between wild boars and domestic animals is of logical importance in disease control and eradication programmes. Having in mind this fact, the special attention should be given to active surveillance of wild boars population in the areas where close contact with domestic swine is possible. The measures should include the serological monitoring of wild boars and free-roaming domestic swine, even the prohibition of extensive grazing, pathological examination of the trunci deriving from shot wild boars. The study underlines the importance of improving surveillance strategies for pathogens shared between wildlife and domestic animals and the need to increase disease awareness of hunters, farmers and veterinary practitioners. In the future, a better connection between veterinary service and experts from hunting area is needed in order to solve to problems comprehensive way.

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References

1. Artois M., Delahay R., Guberti V. and Cheeseman C.: Control of Infectious Diseases of Wildlife in Europe. The Veterinary Journal, 162, 141-152, 2001
2. Boadella M., Ruiz-Fons J.F.,Vicente J., Martın J., Segales J. and Gortazar, C.: Seroprevalence Evolution of Selected Pathogens in Iberian Wild Boar. Transboundary and Emerging Diseases,59, 395–404, 2012
3. Da Silva D., Müller G.: Parasites of the respiratory tract of *Sus scrofa scrofa* (wild boar) from commercial breeder in southern Brazil and its relationship with *Ascaris suum*. Parasitol Res 112:1353-1356, 2013
4. Došen R., Prodanov-Radulović J., Pušić I., Stojanov I., Petrović T.: Man, wild and domestic pigs : Major risk points in disease transmission and perspective. Book of Abstracts, 2nd International symposium on hunting 'Modern aspects of sustainable menagement of game population', 17-20 October, 2013, Novi Sad, Serbia organized by Faculty of Agriculture, Novi Sad, 2013, 97
5. Došen R., Prodanov-Radulović J., Pušić I., Ratajac R., Stojanov I., Grubač S.: The uncontrolled use of antibiotics in pig production - a threat to public health. XVI International congress Feed technology, October 28-30, 2014, Novi Sad, organized by Institute of food technology, 2014, 20-24
6. Frölich K., Thiede S., Kozikowski T., Jakov, W.: A Review of Mutual Transmission of Important Infectious Diseases between Livestock and Wildlife in Europe. Ann. N.Y. Acad. Sci., 969, 4-13, 2002
7. Garcia-González A., Pérez-Martin J.E., Gamito-Santos J. A., Calero-Bernal R., Alcaide Alfonso M., Frontera Carrión E. M.: Epidemiologic Study of Lung Parasites (Metastrongylus spp.) in Wild Boar (Sus scrofa) in Southwestern Spain. Journal of Wildlife Diseases, 49,1, 157-162, 2013
8. Järvis T., Kapel Ch., Moks E., Talvik H., Mägi E.: Helminths of wild boar in the isolated population close to the northern border of its habitat area. Veterinary Parasitology, 150, 366-369, 2007
9. Laddomada A.: Incidence and control of CSF in wild boar in Europe. Vet Microbiol, 73, 121-130, 2000
10. Laaaksonen S. and Paulsen P.: Hunting hygiene, Wageningen Academic Publishers, 2015

11. Le Potier M.F., Mesplede A., Vannier, P.: Classical swine fever and other pestiviruses. In: Diseases of swine, ed. Straw B. E., Zimmerman, J. J., D'Allaire, S., Taylor D. J., 9th edn. Oxford: Blackwell Publishing, 2006, 309-322
12. Meng X. J., Lindsay D. S. and Sriranganathan N.: Wild boars as sources for infectious diseases in livestock and humans. *Phil. Trans. R. Soc*., B 364, 2697-2707, 2009
13. Montagnaro S., Sasso S., De Martino L., Longo M., Iovane V., Ghiurmino G., Pisanelli G., Nava D., Baldi L., Pagnini U.: Prevalence of Antibodies to Selected Viral and Bacterial Pathogens in Wild Boar (Sus scrofa) in Campania Region, Italy. *Journal of Wildlife Diseases*, 46,1, 316–319, 2010
14. Petrović T., Lupulović D., Lazić G., Prodanov-Radulović J., Došen R., Lazić S.: A serological survey on porcine reproductive and respiratory syndrome (PRRS) virus infection in Serbian wild boars population. Proceedings, EuroPRRS2012 Symposium Understanding and combating PRRS in Europe, COST Action FA902, 10th - 12th October 2012, Budapest, Hungary, organized by Faculty of Veterinary Science, Roslin Institute, 2012, 87-88
15. Prodanov J., Došen R., Orlić D., Maljković M., Pušić I., Stojanov I., Radulović G.: Clinical and pathomorphological diagnostics in control of health status of wild boars. Proceedings The 9th Regional Symposium in Animal Clinical Pathology and Therapy „Clinica veterinaria", Jun 19-21 Jun, Subotica, Serbia, 2009a,133-134
16. Prodanov J., Došen R., Pušić I., Petrović T., Orlić D., Maljković M., Lupulović D.: The control of classical swine fever virus presence in wild boars population. Biotechnol. Anim. Husb. 25, 5-6, 879-885, 2009b
17. Prodanov-Radulović J., Došen R., Pušić I., Orlić D., Stojanov I., Radulović G.: Verinozna pneumonija divljih svinja. Arh.vet. med., 3, 2, 19-25, 2011
18. Prodanov-Radulović J., Došen R., Pušić I., Petrović T., Stojanov I.: Health status control of wild boars in the hunting area of Vojvodina region. Proceedings, 10th International Symposium Modern Trends in Livestock Production, 2 - 4 October, Belgrade, organized by Institute for Animal Husbandry, Belgrade, 2013a,1182-1188
19. Prodanov-Radulović J., Došen R., Pušić I., Stojanov I., Petrović T., Urošević M.: The bacterial infections of respiratory tract of wild boars. 2nd International symposium on hunting Modern aspects of sustainable management of game population, 17-20 October, Novi Sad, Serbia, organized by Faculty of Agriculture, Novi Sad, 2013b, 220-224
20. Prodanov-Radulović J., Došen R., Petrović T., Polaček V., Lupulović D., Stojanov I., Grubač S.: Antibodies to selected viral disease agents in hunted wild boars in Vovodina region. 3rd International symposium on hunting Modern aspects of sustainable management of game population, 26-28 September, Zemun - Beograd, Serbia, organized by Balkan Wildlife Scientific Society, Novi Sad, 149-153, 2014a
21. Prodanov-Radulović J., Došen R., Stojanov I., Polaček V., Živkov-Baloš M., Marčić D., Pušić I.: The interaction between the swine infectious diseases agents and low levels of mycotoxins in swine feed. *Biotechnol. Anim. Husb*., 30,3,433-444, 2014b
22. Reiner G., Fresen C., Bronnert S., Haak I., Willems H.: Prevalence of *Haemophilus parasuis* infection in hunted wild boars (Sus scrofa) in Germany. *Journal of Wildlife Diseases*, 46,2, 551-555, 2010
23. Roić B., Jemersić L., Terzić S., Keros T., Balatinec J.,Florijancic T.: Prevalence of antibodies to selected viral pathogens in wild boars (sus scrofa) in Croatia in 2005–06 and 2009–10. *Journal of Wildlife Diseases*, 48, 1,131–137, 2012
24. Rojo-Vazquez F.A., Pardo-Liedias J., Francos-Von Hunefeld M., Cordero-Sanchez M., Alamo-Sanz R., Hernendez-Gonzalez A., Brunetti E., Siles-Lucas M.: Cystic Echinococcosis in Spain: Current Situation and Relevance for Other Endemic Areas in Europe. PLoS Negl Trop Dis, 5, 1, e893.doi: 10.1371 /journal.pntd. 0000893, 2011
25. Rossi S., Fromont E., Pontier D., Crucière C., Hars J., Barrat J., Pacholek X., Artois M.: Incidence and persistence of classical swine fever in free-ranging wild-boar (*Sus scrofa*). *Epidemiol. Infect*.,133, 559-568, 2005
26. Ruiz-Fons F., Segalés J., Gortázar C.: A review of viral diseases of the European wild boar: Effects of population dynamics and reservoir role. Vet J., 176, 158-169, 2008

27. Sedlak K., Bartova E., Machova J.: Antibodies to Selected Viral Disease Agents in Wild Boars from the Czech Republic. *Journal of Wildlife Diseases*, 44,3,777–780, 2008
28. Senlik B., Cirak V.Y., Girisgin O. Akyol C.V.: Helminth infections of wild boars (*Sus scrofa*) in the bursa province of Turkey. *Journal of Helminthology*, 85, 404-408, 2011
29. Vengust G., Grom J., Bidovec J. A. Kramer M.: Monitoring of Classical Swine Fever in Wild Boar (Sus scrofa) in Slovenia. J. Vet. Med. B, 53, 247–249, 2006
30. Wu N., Abril C., Hinić V., Brodard I., Thűr B., Fattebert J., Hüssy D., Ryser-Degiorgis M-P.: Free ranging wild boar: a disease threat to domestic pigs in Switzerland? *Journal of Wildlife Diseases*, 47, 4, 868-879, 2011.
31. Yoon B., Kim H.-C., Kim J.-T.: Lung Worm (Metastrongylus elongatus) Infection in Wild Boars (Sus scrofa) of the Demilitarized Zone, Korea. *Journal of Wildlife Diseases*, 46(3), 1052-1054, 2010