

"Modern aspects of sustainable management of game populations"

Proceedings of 3rd International Symposium on Hunting with Abstract book



Organizers



Zemun-Belgrade, 26-28. September, 2014.

**3rd INTERNATIONAL SYMPOSIUM ON
HUNTING**

**“MODERN ASPECTS OF SUSTAINABLE
MANAGEMENT OF GAME
POPULATION”**

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International Symposium
on Hunting
with Abstract Book**

Zemun-Belgrade, Serbia, 26-28 September, 2014.

ISBN: 978-86-7520-302-5

UDC: 639.1(082)

International symposium on hunting

“Modern aspects of sustainable management of game population”

Publisher

Balkan Wildlife Scientific Society,

Trg Dositeja Obradovića 8, 21000, Novi Sad, Serbia

Phone: +38121 485 34 92; www.huntsymposium.com

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MICROECONOMIC ANALYSIS OF GAME POPULATION MANAGEMENT IN HUNTING GROUNDS

Popović Z.¹, Živković D.¹, Lavadinović V.²

Summary: Microeconomic approach to economic considerations implies focusing on business developments of the operators or their specific activities. This analysis provides insight into financial part of management of *Barajevska reka* hunting ground in order to comprehend the growing costs and harvest value of the most abundant game species in the hunting ground. The planned harvest value is EUR 20.529 or 18.23% of the total value of the breeding stock. Harvested big game (roe deer and wild boar) accounts for 66.67% of the total planned harvest, while small game accounts for 33.33% of the planned harvest. The planned roe deer harvest accounts for 62.85% of the harvest value. Management result values in 2013 show that thus evaluated game reports operating loss with cost-effectiveness ratio of 0.78, production profitability rate of -28.87 and loss of EUR 43.68 per 100 hectares of hunting area. This clearly indicates that funding of hunting ground management requires provision of funds from other sources, which in this case means from membership of hunters. Indirect costs of management for hunting ground users account for 62.1%, while direct costs of game growing and maintaining hunting grounds account for 37.9% of total management costs.

Profit in the production may be realized through implementation of big game harvest plan in the market and fulfilment of the small game harvest plan by hunters who are the members of the association. Significant enhancement of the economic performance of game population management can be made by improving the game management by increased share of roe deer in the medal, reducing losses and increasing real growth in some game species within the acceptable biological limits.

Key words: game, hunting ground, management value, expenditures

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**MIKROEKONOMSKA ANALIZA GAZDOVANJA
POPULACIJAMA DIVLJAČI U LOVIŠTU**

Popović Z.¹, Živković D.¹, Lavadinović V.²

Sažetak: Mikroekonomski pristup ekonomskim razmatranjima podrazumeva stavljanje naglaska poslovnih dešavanja privrednih subjekata ili njihovih pojedinih delatnosti. Ova analiza omogućava uvid u finansijski deo gazdovanja lovištem „Barajevska reka“ kako bi se sagledali troškovi gajenja i vrednost odstrela najzastupljenijih vrsta divljači u lovištu. Vrednost planiranog odstrela je 20,529 eur ili 18.23 % od ukupne vrednosti matičnog fonda. Od ukupno planiranog odstrela 66.67% je odstrel krupne divljači (srna i divlja svinja), dok sitnu divljač učestvuje sa 33.33% planiranog odstrela. Planirani odstrel srna učestvuje sa 62,85% vrednosti odstrela. Na osnovu vrednosti rezultata proizvodnje u 2013. godini može se videti da ovako valorizovana divljač iskazuje poslovni gubitak sa koeficijentom ekonomičnosti od 0.78, stopom rentabilnosti proizvodnje od -28.87 i gubitkom od 43,68 Euro na 100 ha lovne površine. Ovo jasno ukazuje da se za finansiranje ove proizvodnje moraju obezbediti sredstva iz drugih izvora, što je kod ovog korisnika lovišta iz članarine lovaca. Opterećenja korisnika lovišta sa indirektnim troškovima proizvodnje su 62.1%, dok na direktne troškove gajenja divljači i održavanja lovišta odlazi 37.9% ukupnih troškova proizvodnje.

Kao mogućnost ostvarenja dobiti u proizvodnji je realizacija plana odstrela krupne divljači na tržištu i ispunjenje realizacije plana odstrela sitne divljači od strane lovaca članova udruženja. Značajno poboljšanje ekonomskih rezultata gazdovanja populacijama divljači, može se izvršiti i unapređenjem načina gazdovanja divljači i to povećanjem učešća srndaća u medalji, smanjenjem gubitaka i povećanjem realnog prirasta kod nekih vrsta divljači u prihvatljivim biološkim granicama.

Ključne reči: divljač, lovište, vrednost proizvodnje, rashodi

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NUMBER DYNAMICS AND PRESENT-DAY RESOURCES OF MAJOR GAME ANIMALS IN RUSSIA

Vaisfeld, M.A.¹, Pushkaryov, S.V.²

Summary: 250 species of mammals and over 620 species of birds resides in Russia. 208 of them are game species. The most valuable ones are even-toed ungulates, fur species, middle-sized and big predators and some tens of bird species. Russian hunting ground occupies 1475834 hectares. During the period 2008..2013 years, in the country as a whole, the number of moose, roe deer, red deer and musk deer has increased (+44, 21, 20 and 76 % , respectively), whereas the one of wild boar and reindeer has been fallen. Moose, reindeer and roe deer population give 73 % of all Russian ungulates' number. In Russia, the number in 2013 and the size of legal extraction in 2012 are the following: for elk – 871500 and 10882 heads respectively, boar – 398530 and 57980, roe (European and Siberian) – 966600 and 30101, red deer –22500 and 4180, wild reindeer – 958000 and 23859, musk deer – 230000 and 5485, brown bear – 210000 and 4085, lynx -- 22510 and 254, wolf -- 44400 and 8361, sable –1.2..1.3M and 174..206K, red fox – 660.7K and 150K; ducks – 25M and 500K, geese -- 3.5M and 100K, hazel grouse – 20.6M and 212K, black grouse – 15M and 64K, capercaillies – 3M and 26K. At present, the cost of extracted production of valuable mammal species is estimated at 54 billion rubles, present-day resource -- 80-87G, the potential one – 580G. The estimate for extraction of wildfowl birds is 50..60 billion rubles. According to expert estimates, potential ungulate and fur species' number in our country is 5..10 times higher than the actual stock. Therefore, one of the most important tasks is increasing land productivity in accordance with their ecological capacity.

Key words: game species, game animals, Russia, number dynamics, resources, mammals, birds

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DINAMIKA BROJNOSTI I TRENUTNO STANJE GLAVNIH VRSTA DIVLJAČI U RUSIJI

Vaisfeld, M.A.¹, Pushkaryov, S.V.²

Sažetak: Rusiju nastanjuje 250 vrsta sisara i preko 620 vrsta ptica od kojih 208 spada u divljač. Najvrednije vrste su dvopapkari, krznašice, srednje i krupne zveri kao i desetine ptičijih vrsta. Ruska lovišta obuhvataju 1,475,834 ha. U periodu od 2008 do 2013. godine u celoj zemlji je brojnost losova porasla za 44%, srna za 21%, običnog jelena za 20% i mošusnog jelena za 76%, dok je brojnost divlje svinje i jelena lopatara opala. Populacija losova, irvasa i srna čini 73% svih papkara u Rusiji. U Rusiji brojnost u 2013. godini i legalni odstrel u 2012. godini je: za losa 871,500 i 10,882; za divlju svinju 398,530 i 57,980; za srnu (evropsku i sibirsku) 966,600 i 30,101; za običnog jelena 22.500 i 4,180; za irvasa 958,000 i 23,859; za mošusnog jelena 230,000 i 5,485; za medveda 210,000 i 4,085; za risa 22,510 i 254; za vuka 44,400 i 8,361; za samura između 1.2 i 1.3 miliona i 174,206; za lisicu 660,700 i 150,000; za patke 25 miliona i 500,000; za guske 3.5 miliona i 100,000; za leštarku 20.6 miliona i 212,000; za tetreba ruževca 15 miliona i 64,000; za velikog tetreba 3 miliona i 26,000. Sadašnja vrednost odstrela važnijih sisara je procenjena na 54 milijarde rubalja, današnji resursi -- 80-87G, dok je potencijalni -- 580G. Procena odstrela barskih ptica je oko 50-60 milijardi rubalja. Prema procenama stručnjaka brojnost papkara i krznašica u zemlji bi mogla da bude između 5 i 10 puta veća od trenutne. Zbog toga je jedna od najvažnijih zadataka povećanje produktivnosti staništa u skladu sa njihovim ekološkim kapacitetom.

Ključne reči: divljač, divlje životinje, Rusija, dinamika brojnosti, resurs, sisari, ptice

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**DISTRIBUTION AND POPULATION CHARACTERISTICS OF GAME
MAMMALS OF WEST-SIBERIAN TAIGA – TRENDS FROM
“PERESTROYKA” BEGINNING**

Piminov V. N.¹, Sinitsyn A. A.¹, Saveljev A. P.¹

Summary: The estimation of the modern status and trends of development of populations of the most important hunting mammals in Western Siberia - in region where oil and gas recovery intensively develops - is given. Materials testify to differently referred trends. The most sentinel to industrial development of territory have appeared the migratory ungulates - a reindeer and moose. Good adaptive abilities and stability of populations are shown by brown bear, sable, and muskrat. Building of new roads and new settlements, and also the human induced successions of taiga habitats positively influence on populations of red fox and mountain hare. Historically, value of hunting for the population of Western Siberia was great. Authors consider that the press on the hunting animals will amplify with expansion of exploitation of mineral resources and improvement of availability of territories.

Key words: game mammals, resources, population trends, hunting, West Siberia

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**DISTRIBUCIJA I KARAKTERISTIKE POPULACIJE DIVLJAČI IZ KLASSE
SISARA ZAPADNO-SIBIRSKJE TAJGE – TRENDVI
„PERESTROJKINOG“ POČETKA**

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Sažetak: Procena statusa i savremenih trendova razvoja populacija najvažnijih vrsta lovne divljači u zapadnom Sibiru – regionu sa intenzivnim eksploatacijom gasa i nafte, urađena je u ovom radu. Dostupni podaci svedoče o različitim trendovima. Najprilagođenije populacije industrijskom razvoju teritorije su migratorni ungulati-jeleni i losovi. Dobre adaptivne sposobnosti i stabilnost populacije pokazuje mrki medved, samur i bizamski pacov. Izgradnja novih puteva i naselja, kao i antropogeni uticaj na smanjivanje tajgi, ima pozitivan uticaj na populacije crvene lisice i planinskog zeca. Istorijski gledano, lov predstavlja izuzetnu ekonomsku dobit za narod zapadnog Sibira. Autori predviđaju da će sa porastom eksploatacije prirodnih resursa da se poveća i pritisak na populacije lovne divljači, što može i da poveća teritoriju njihovog rasprostranjenja.

Ključne reči: divljač, resursi, populacioni trend, Zapadni Sibir

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PRELIMINARY RESEARCH OF DAMAGES BY RED DEER TO FOREST TREES IN THE AREA OF MOSLAVAČKA GORA (MIDDLE CROATIA)

Ozimec S.,¹ Kovačević J.¹, Kulić A.¹, Florijančić T.¹, Bošković I.¹

Summary: In Croatia there are 1,060 hunting grounds on total surface of 5,012.905 ha. They are established for breeding, protection and hunting the game, with an aim to preserve natural balance of the wildlife flora, fauna and their habitats. National Classification of habitats defines 11 main classes of habitats, eight of which contain most of the natural and semi-natural types of habitats and ecosystems, while three contain various anthropogenic habitats. Composition, distribution and suitability of habitats for managing game species was analyzed and compared for two selected hunting grounds in the lowland part of Croatia. The first is III/28 “Posavina Forests” (surface of 14.071 ha) in Sisak-Moslavina County, and the second, XII/107 “Garčin” (7.496 ha) is located in Brod-Posavina County. Anthropogenic impact on landscape and biodiversity is stronger in “Garčin” since 65% of habitats belong into class of cultivated land. In “Posavina Forests” the percentage of these habitats is 23%. Comparison of forests habitats showed higher value (57%) in “Posavina Forests” while in “Garčin” it is 28%. Forest habitats comprise mainly deciduous mixed forests of pedunculate oak and common hornbeam; pedunculate oak, black alder and field ash forests. Patchy distribution of open, large agricultural surfaces with grasslands, thickets, forests and channels in “Garčin” hunting ground enables management of roe deer, the European hare and pheasant as the main hunting game. More forested „Posavina Forests“ hunting ground, with lack of open habitats, has good conditions for management of red deer, roe deer and wild boar.

A negative impact of flooding is more frequent in the “Posavina Forests”. During some extreme events about 80% of the hunting ground can be flooded, causing mortality and migration of game. Thus, the appropriate mitigation measures in game management needs to be planned.

Key words: habitat, hunting ground, game, Croatia

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**UVODNA ISTRAŽIVANJA ŠTETA OD JELENSKE DIVLJAČI NA
ŠUMSKOM DRVEĆU NA PODRUČJU MOSLAVAČKE
GORE (SREDIŠNJA HRVATSKA)**

Ozimec S.,¹ Kovačević J.¹, Kulić A.¹, Florijančić T.¹, Bošković I.¹

Sažetak: U Hrvatskoj postoji 1.060 lovišta na ukupoj površini od 5.012.905 ha. Ustanovljena su za uzgajanje, zaštitu i lov divljači, sa ciljem očuvanja prirodne ravnoteže između divlje flore, faune i njihovih staništa. Nacionalna klasifikacija staništa definiše 11 glavnih klasa staništa, od kojih osam uključuje većinu prirodnih i poluprirodnih stanišnih tipova i ekosistema, dok tri uključuju razna antropogena i veštačka staništa. Analizirani su sastav, raspodela i prikladnost staništa za gazdovanje lovnom divljači u dva odabrana lovišta u nizinskom delu Hrvatske. Prvo je III/28 "Posavske šume" (površina 14 071 ha) u Sisačko-moslavačkoj županiji, a drugo, XII/107 "Garčin" (7 496 ha) se nalazi u Brodsko-posavskoj županiji. Uticaj čoveka na predeo i biodiverzitet je snažniji u lovištu "Garčin" gde je 65 % staništa iz klase obradivih površina, a u lovištu "Posavske šume" takvih staništa je 23 %. Poredba šumskih staništa pokazuje višu vrednost (57 %) za "Posavske šume" dok je 28 % u lovištu "Garčin". Šumska staništa uključuju uglavnom listopadne mešovite šume lužnjaka i graba; lužnjakove i jasenovo-jovine šume. Mozaički razmeštaj velikih obradivih površina sa travnim i žbunastim formacijama i kanalima u lovištu "Garčin" osigurava gazdovanje srnom, zecom i fazanom kao glavnim lovnom divljači. U šumovitijem lovištu "Posavske šume" nedostaju otvorena staništa, ali su uslovi dobri za gazdovanje jelenom običnim, srnom i divljom svinjom. U ovom lovištu je češći negativni uticaj poplava. Dok traje velika poplava oko 80 % lovišta je pod vodom, što uzrokuje stradavanje i migraciju divljači. Zato je u gazdovanju divljači potrebno primeniti adekvatne mere za ublaženje negativnog uticaja poplava.

Ključne reči: stanište, lovište, divljač, Hrvatska

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PRINCIPLES OF WOLF MONITORING IN SLOVENIA

Kos, I.¹, Potočnik, H.¹, Jelenčič, M.¹, Kljun, F.¹, Raženj, N.¹, Majić Skrbušek, A.¹,

Summary: Wolf is a charismatic canid species, distributed over a wide spectrum of landscapes with very different land use by humans. In Balkan Peninsula wolves mainly inhabit landscapes dominated by humans. Humans profoundly affect their existence, either through direct influences on the wolf populations themselves or also through indirect influences on their main prey, the wild ungulates. In this region wolves have been regularly hunted throughout the history, and there are illegal killings documented since in places where they have been protected in the recent time. A critical background for conservation management of this species is a firm knowledge of population status and its trends. Scientific basis for monitoring is also crucial for the human dimension perspective of management since it makes the acceptance of the estimated parameters easier.

In Slovenia, we recognized the need for integrative, holistic monitoring of our wolf population. Establishment of the monitoring was implemented in the 2010 to 2013 period as one of the actions in LIFE+ project SloWolf. Different complementary monitoring approaches were utilized: extensive registering signs of wolf presence, systematic howling surveys, estimation of population abundance and dynamics through genetic mark-recapture with non-invasive genetic samples, establishment of pack number and their characteristics through genetic parentage analysis, habitat use through GPS telemetry and snow tracking, and genetic evaluation of wolf-dog hybridization. Different approaches were tested and optimized through three years of intensive monitoring to provide a robust, cost effective monitoring system for Slovenian wolves.

Key words: wolf monitoring, Dinaric wolf population, Slovenia,

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PRINCIPI MONITORINGA VUKOVA U SLOVENIJI

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Sažetak: Vuk je harizmatična vrsta kanida, koja je široko rasprostranjena predelima, ko ju raznovrsno korišćeni od strane ljudi. Na Balkanskom poluostrvu vukovi uglavnom nastanjuju predele gde dominiraju ljudi. Ljudi značajno utiču na njihov opstanak, bilo direktno na populaciju vukova ili indirektno na njihov glavni plen kao što su divlji papkari. U ovom regionu vukovi su kroz istoriju redovno lovljeni, dok je nezakonit odstrel dokumentovan na područjima gde su oni od skoro zaštićeni. Važna osnova za očuvanje ove vrste je solidno znanje o stanju i trendovima u populaciji. Naučna osnova za monitoring je takođe značajna iz ljudske perspektive gazdovanja, pošto ona čini prihvatanje procenjenih parametara lakšim.

U Sloveniji smo prepoznali potrebu za integrativnim i holističkim monitoringom naših populacija vukova. Uspostava monitoringa je primenjena u period od 2010- 2013. godine kao jedno od aktivnosti u LIFE+ projektu SloWolf. Različiti dopunjujući pristupi monitoringa su bili korišćeni: obimna registracija znakova prisustva vukova, sistematsko istraživanje zavižanja, procena brojnosti i dinamike populacije kroz metod “označi-ponovo uhvati” sa ne-invazivnim genetskim uzorcima, osnivanje oznaka čopora i njihovih osobenosti kroz genetsku analizu roditeljstva, korišćenje staništa kroz GPS telemetriju i praćenje tragova u snegu, i genetička procena hibridizacije pasa i vukova. Različiti pristupi su testirani i prilagođeni kroz trogodišnji period monitoringa da obezbede jak i finansijski efikasan sistem monitoringa Slovenačkih vukova.

Ključne reči: monitoring vukova, Dinarska populacija vukova, Slovenija,

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PREDICTING WOLF-LIVESTOCK CONFLICT LEVELS ACROSS POTENTIAL HABITAT GRADIENT (PRELIMINARY MODELS)

Potočnik H.,¹ Pecl M.¹, Skrbinšek T.¹, Kos I.¹

Summary: Wolves preying on livestock fall into a permanent conflict with humans. However, predation risk on livestock seems to be different across areas of wolf presence. Natural prey spectrum and densities can play an overlooked role attenuating conflicts and favouring coexistence. Wolf diet from northern Dinaric wolf population was studied in an area occupied by 8 to 11 packs using method of scat analysis. Relations between wild ungulate densities, small cattle (sheep and goat) abundances and wolf's diet and livestock depredation rates were studied. Prediction models (GLMM and GM) have been used to explore factors that influence predation risk on small cattle (sheep and goats) across the area. Estimates of relative wild ungulate population densities were obtained from harvest/mortality statistics plotted in 1 km grids. Among wild prey species, cervids (red deer and roe deer) and wild boar, were the main prey of wolves in all studied packs ranged from 78 % to 98 % (F.O.) in their diet. However there was largest variation of cervids in their diet between packs ranged from only 35 % to over 83 %. There was a positive correlation between red deer densities and amount of cervids in wolf's diet. Models show that red deer abundance (besides roe deer and small cattle density) is the most important factor that influences preying/feeding risk on small cattle. The model was extrapolated over entire Slovenia, showing actual hot spots – conflict areas in wolf presence areas as well as potential conflict hot spots in a case of colonizing new areas. Therefore, adequate management of red deer as well as wolf population management seems to be very important issue in areas with high predation risk on domestic animals.

Key words: wolf's diet, predation risk, small cattle, red deer, natural ungulate densities, prediction risk models

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PREDVIĐANJE NIVOA SUKOB A VUK-STOKA PREKO GRADIJENATA POTENCIJALNOG STANIŠTA (PRELIMINARNI MODEL)

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Sažetak: Vučji napadi na domaću stoku potpadaju pod stalni sukob sa ljudima. Ipak, izgleda da rizik od predatorstva varira na području gde su vukovi prisutni. Spektar i gustina prirodnog plena mogu da igraju predviđajuću ulogu u ublažavanju sukoba i favorizovanju suživota. Vučja ishrana je istraživana na populaciji vukova sa severnih Dinarida u oblasti koju zauzima između 8 i 11 čopora metodom analize izmeta. Odnosi između gustine divljih papkara, brojnosti sitne stoke (ovce i koze) i vučje ishrane kao i stope predatorstva na domaćoj stoci, su bili istraživani. Predviđajući modeli (GLMM i GM) su korišćeni za istraživanje faktora koji utiču na rizik od predatorstva na sitnoj stoci (ovca i koza) u datoj oblasti. Procene relativne gustine populacija divljih papkara su dobijene na osnovu podataka o mortalitetu i odstrelu sa 1km koordinatne mreže. Među divljači koja predstavlja plen, cervide (obični jelen i srna) i divlja svinja su glavni plen vukovima u svim istraživanim čoporima i zastupljeni su od 78% do 98% (F.O.) u njihovoj ishrani. Ipak bila je prisutna najveća varijacija cervida u njihovoj ishrani među čoporima koja se kretala od 35 % do preko 83 %. Postojala je pozitivna korelacija između gustine jelena i količine cervida u vučijoj ishrani. Modeli pokazuju da je rasprostranjenost jelena (osim srna i sitne stoke) najvažniji faktor koji utiče na rizik od predatorstva/ishrane sitnom stokom. Model je bio ekstrapoliran za celu Sloveniju, pokazujući trenutne kritične tačke – oblasti sukoba na područjima rasprostranjenja vukova kao i potencijalne kritične tačke u slučaju kolonijalizacije novih područja. Zbog toga odgovarajuće mere gazdovanja jelenom kao i vučjom populacijom izgleda da predstavljaju veoma važno pitanje

Ključne reči: vučja ishrana, rizik od predatorstva, sitna stoka, jelen, prirodna gustina papkara, predviđajući modeli rizika

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PREDATION OF EGGS IN ARTIFICIAL GROUND BIRD NESTS IN PRE-ALPINE FOREST OF MENINA MOUNTAIN (SLOVENIA)

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Summary: The present study investigates predation of eggs in artificial ground nests on different altitude zones of forest in the habitat areas of capercaillie (*Tetrao urogallus*). We investigated whether the rate of predation on artificial nests varies among altitude zones of forest in the pre-alpine area of Menina Mountain, Slovenia, and to establish which predator types are the most common within the particular altitude zone. We also explored which environmental factors increased predation rates on the nests. In each of the three altitude zones we set artificial nests with two natural and one artificial egg, fixed in the ground. All together we placed 295 artificial nests in 30 transects and three altitude zones. The artificial eggs were exposed between 20th of May and 20th of June to simulate hatching period of capercaillie. During the exposure experiment we carried out four inspections of the simulated nests. They were highly depredated (81 to 96 %) in all three zones. The highest rate and dynamic of predation was found out on the highest altitude zone, which we interpreted as a consequence of large proportion of open alpine pastures with high wild boar and small carnivores activity. As identified predators, small carnivores were the most dominate predators on the highest (1200-1500 m a.s.l.) and lowest altitude zones (400-700 m), and the wild boar was identified as most frequent predator in the intermediate altitude zone (800-1200 m) Using descriptive analyzes we confirmed our hypothesis that the predation of artificial nests by small carnivores will be higher near the forest edge, and that predatory pressure by wild boar will be higher near wild boar feeding sites. Even though artificial nests test does not show realistic nest success of capercaillie, it certainly indicates high predation risk and different predation as well as predator trends in particular zones.

Key words: artificial nests, predation rates, small carnivores, wild boar, capercaillie, Slovenia, pre-alpine mountain

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PREDATORSTVO JAJA U VEŠTAČKI PODIGNUTIM GNEZDIMA U PRIALPSKIM ŠUMAMA PLANINE MENINA (SLOVENIJA)

Potočnik H.,¹ Pecl M.¹, Skrbinšek T.¹, Kos I.¹

Sažetak: Ova studija istražuje predatorstvo jaja u veštački podignutim gnezdima na različitim visinama šumskog staništa velikog tetreba (*Tetrao urogallus*). Ispitali smo da li se odnos predatorstva u veštačkim gnezdima razlikuje po visinskim zonama šuma u podalpskoj oblasti planine Menina u Sloveniji i ustanovili koje vrste predatorstva su uobičajene po određenim visinskim zonama. Istraživali smo koji faktori životne sredine povećavaju predatorstvo na gnezdima. U svakoj od tri visinske zone smo postavili veštačka gnezda, pričvršćena na zemlju, sa dva prirodna i jednim veštačkim jajetom. Ukupno smo postavili 295 veštačkih gnezda na 30 transekata i tri visinske zone. Veštačka jaja su bila izložena u periodu od 20. maja do 20. juna da bi se simulirao period pilenja kod velikog tetreba. Tokom ovog perioda su sprovedene četiri inspekcije simulatorima gnezda. Ona su bila znatno opustošena (81 do 96 %) u sve tri zone. Najveća stopa i dinamika predatorstva je uočena u najvišoj visinskoj zoni, što smo protumačili kao posledicu visoke zastupljenosti otvorenih planinskih pašnjaka sa znatnom aktivnosti divljih svinja i sitnih zveri. Od identifikovanih predatora, sitne zveri su bile najdominantniji predatori u najvišoj (1200-1500 mnv) i najnižoj (400-700 mnv) visinskoj zoni, dok je divlja svinja najčešći predator u srednjoj visinskoj zoni (800-1200 mnv). Korišćenjem opisne analize smo potvrdili našu hipotezu da će predatorstvo veštačkih gnezda od strane sitnih zveri biti veće na ivici šume i da će predatorstvo divlje svinje biti veće bliže njenim hranilištima. Iako testiranje veštačkih gnezda ne prikazuje stvarni uspeh gnežđenja velikog tetreba, ono svakako ukazuje na visok rizik od predatorstva i različite predatore, kao i trendove predatorstva u različitim visinskim zonama.

Ključne reči: veštačka gnezda, stopa predatorstva, sitne zveri, divlja svinja, veliki tetreb, Slovenija, podalpske planina

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**ABUNDANCE CYCLICITY OF ERMINE (MUSTELA
ERMINEA L., 1758) IN TRANSBAIKAL KRAI (RUSSIA)**

Agafonov G.,¹ Erdakov L.²

Summary: Abundance dynamics of ermine has been studied for a long time. Cyclicity of this dynamics with periods of 2-11 years in different parts of range is registered. We analyzed data on acquisition of ermine furs in 14 districts of Transbaikalia for the period of 19 years (1971-89). We assumed that this data generally reflects long-term abundance dynamics of ermine in hunting area. Analysis of abundance dynamics of ermine basing on the acquisitions of furs in different districts of Transbaikalia allowed us to identify that complex curves of acquisition dynamics are superpositions of different cycles, which are distinct in period and strength. With the employment of time-series analysis, which is graphically depicted as chronograms of abundance dynamics in different districts, we constructed distinctive figures of rhythm spectra and conducted visual comparison of this figures for different districts. We distinguished all districts into three groups according to the form of spectrum of abundance cycles. The first group primarily includes low frequency rhythms (12-22 years), in the second group these rhythms are totally absent. The third group of spectra is intermediate; it includes rhythms in all frequency bands which are specific for this specie. High frequency rhythms are indicative for the majority of spectra, and about 4 years cycles are indicated in all spectra without any exclusion. For the first time description for low frequency cycles (16-26 years) were given. It seems that most probably the spectrum of 6-8 visible periodicities is specific for ermine, but only part of these periodicities appear in each region. Full spectrum of rhythms of ermine, probably, will be displayed using longer-term records.

Key words: ermine populations, rhythms, spectral analysis.

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**CIKLIČNOST BROJNOSTI HERMELINA (MUSTELA
ERMINEA L., 1758) U TRANSBAJKALSKOM KRAJU
(RUSIJA)**

Agafonov G.,¹ Erdakov L.²

Sažetak: Dinamika brojnosti hermelina se istražuje već dugo vremena. Cikličnost ove dinamike sa periodima od 2-11 godina je primećena u različitim delovima njihovog rasprostranjenja. Analizirali smo podatke o nabavci krzna hermelina u 14 oblasti Transbajkalskog kraja u periodu od 19 godina (1971-89). Pretpostavili smo da ovi podaci u suštini ukazuju na dugoročnu dinamiku brojnosti hermelina u lovnoj oblasti. Analiza dinamike brojnosti hermelina zasnovana na nabavci krzna iz različitih oblasti Transbajkala nam je omogućila da uočimo da su složene krive dinamike nabavke superpozicije različitih ciklusa, koji se razlikuju po periodu i snazi. Angažovanjem analiza vremenskih serija, koje su grafički prikazane kao hronogrami dinamike brojnosti po različitim oblastima, konstruisali smo svojstvene procene ritma spektra i sprovedi vizuelno poređenje ovih procena za različite oblasti. Razvrstali smo sve oblasti u tri grupe prema obliku spektra ciklusa brojnosti. Prva grupa prvenstveno obuhvata ritmove niskih frekvencija (12-22 godine), u drugoj grupi ovi ritmovi nisu uopšte prisutni. Treća grupa spektra je između; ona uključuje ritmove svih frekvencija grupa koji su specifični za ovu vrstu. Ritmovi visokih frekvencija su nagoveštavajuću za većinu spektra, dok su približno četvorogodišnji ciklusi označeni u svim spektrima bez izuzetka. Ovo je prvi put da je opisana niska frekvencija ciklusa (16-26 godina). Izgleda najverovatnije da spektar od 6-8 vidljivih periodičnosti je osoben za hermelina, ali samo deo ove periodičnosti se javlja u svakoj oblasti. Pun spektar ritma hermelina, verovatno, će biti prikazan korišćenjem dužih vremenskih zapisa.

Ključne reči: populacije hermelina, ritmovi, analiza spektra.

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THE MUSKRAT SKULL VARIATION OF MORPHOMETRIC PARAMETERS TO COMPARING PRIMARY AND SECONDARY INTRODUCANTS

Paulauskas A.¹, Skyrienė G.¹

Summary: The muskrat (*Ondatra zibethicus*) is hunted animals for hunting trophies, fur and financial reasons in many countries. Morphometric parameters can vary in different populations of muskrat. The aim of this work was to perform morphometric parameters analysis of skulls of muskrat in Lithuania (secondary introducents) and to compare with primary introducents (Poland, Finland) with respect to sex and weight. According to Pankakoski et al. (1987), a total of 23 measurements were taken on each skull of muskrat. The skull measurements of secondary introducents (Lithuania) females were mostly larger than those of males ($p < 0.05$). But the muskrat skulls were longer and wider in males than in females of primary introducents (Finland and Poland). The mean values of measurements on condylobasal length (CL), braincase length (BL) and weight (BW) showed that were higher in Finnish and Polish than in Lithuanian populations of muskrat ($p < 0.05$). These can depend on adaptive changes: habitat quality, diet and others. The strong relationship between muskrat body weight and skull length were determined in Lithuania ($r=0.72$, $p<0.001$).

Key words: muskrat, *Ondatra zibethicus*, morphometry, introducents

This study was supported by the Research Council of Lithuania (grant No. LEK-14/2012).

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**VARIJABILNOST MORFOMETRIJSKIH PARAMETARA LOBANJE
BIZAMSKOG PACOVA U CILJU POREĐENJA JEDINKI KOJE SU
PRIMARNO I SEKUNDARNO INTRODUKOVANE**

Paulauskas A.¹, Skyrienė G.¹

Sažetak: Bizamski pacov (*Ondatra zibethicus*) je lovna divljač koja se lovi zbog trofeja, krzna i ekonomske dobiti u mnogim zemljama. Morfometrijski parametri se mogu razlikovati u različitim populacijama bizamskog pacova. Cilj ovog rada bio je da se uradi morfometrijska analiza lobanja bizamskog pacova u Litvaniji (sekundarna introdukcija) i da se uporedi sa jedinkama koje su bile prve introdukovane (Poljska, Finska) u odnosu na pol i starost jedinki. Na osnovu rada Pankakoski i sar. (1987), ukupno 23 parametara je određeno za svaku lobanju. Morfometrijski parametri lobanja ženskih jedinki koje su sekundarno introdukovane (Litvanija) su bili uglavnom veći nego kod muških jedinki ($p < 0.05$). Sa druge strane, kod jedinki primarne introdukcije (Finska i Poljska) lobanje mužijaka bizamskog pacova su bile duže i šire u odnosu na lobanje ženki. Prosečne vrednosti dužine kondilobazalne kosti, dužine i težine lobanje su bile veće u populacijama iz Finske i Poljske u odnosu na populacije bizamskog pacova iz Litvanije ($p < 0.05$). Ove promene mogu biti posledica adaptivnih promena, kvaliteta staništa, načina ishrane i drugih faktora. Uočena je jaka korelacija između telesne mase i dužine lobanje kod jedinki iz Litvanije ($r=0.72$, $p<0.001$).

Ključne reči: bizamski pacov, *Ondatra zibethicus*, morfometrija, introdukcija

Ovo istraživanje je finansirano od strane Research Council of Lithuania (grant No. LEK-14/2012).

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DYNAMICS OF POPULATION NUMBERS AND HARVEST FIGURES FOR RED DEER (*Cervus elaphus*) IN NORTHERN POLAND

Ziolkowska E.¹

Summary: In Poland during last decade number of red deer increased from 130 000 to 217 000 individuals despite increase in numbers of animals harvested from 38 to 69 thousand. The increase in the population numbers of deer elevated the level of damage exerted in cultivated fields, and increased the cost of protecting forest plantations against browsing and bark stripping which amounted in 2012 to 14 million and 40 million euro, respectively. Preliminary results of estimating population numbers, made by objective methods, indicate that data obtained from hunters on the numbers of red deer are gross underestimates. For this reason, an attempt to verify the official data on red deer population number within the 433 thousand hectares of forest administered by the Regional Directorate of State Forests in Torun. During 2007-2013 period there was increase in the population number from 8,3 thousand to 10,6 thousand individuals, despite systematic increase in the number of animals harvested from 2,8 thousand to 4,7 thousand. The respective rates of increase in population numbers and harvest numbers measured as the finite rate of increase (λ), amounted to 4%, and 9% per annum. Using the harvest data, and the finite rate of increase in population, and assuming that the annual net population reaches 20 % of the deer number after the end of hunting season, the probable population number was calculated. The calculations showed that, depending on game management unit, the population numbers were higher by factor of 2 to 3 than the figures provided by hunters, and the population density fluctuated from 8.7 to 106.5 individuals /1000 hectares of forest. The estimated population numbers density of red deer in the studied area was thus higher by 139 % than the official data, and amounted to 24.4 thousand individuals i.e., 49,5 individuals per 1000 ha of forest. It is suggested that the density of red deer should be reduced to 35 individuals/1000 ha of through the increase in harvest quotas to the level of 27% of the population number at the of season of hunts in March.

Key words: population census, hunting statistics, finite rate of increase, underestimating the numbers of red deer

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DINAMIKA BROJNOSTI POPULACIJE I OBIM ODSSTRELA JELENA (*Cervus elaphus*) U SEVERNOJ POLJSKOJ

Ziolkowska E.¹

Sažetak: Broj jelenske divljači u Poljskoj je tokom prethodne decenije porastao sa 130 000 na 217 000 jedinki, uprkos povećanju obima odstrela sa 38 na 69 hiljada. Porast brojnosti jelenske divljači je povećao obim šteta na poljoprivrednim kulturama, kao i troškove zaštite šumskih plantaža od objedanja i guljenja kore. U 2012. godini objedanje je izazvalo štete u vrednosti od 14 miliona evra, a guljenje kore štete od 40 miliona evra. Preliminarni rezultati procene brojnosti populacija jelenske divljači na osnovu objektivnih metoda pokazuju da podaci bazirani na proceni lovaca značajno podcenjuju brojnost jelenske divljači. Iz ovih razloga smo pokušali da proverimo zvanične podatke o brojnosti jelenske divljači u regionalnom direktoratu državnih šuma Torun koji obuhvata 433 hiljada ha šume. Tokom perioda 2007-2013. godine brojnost jelenske divljači je porasla sa 8,3 na 10,6 hiljada jedinki, uprkos povećanju obima odstrela sa 2,8 na 4,7 hiljada. Odgovarajuće stope rasta brojnosti populacija i obima odstrela su merene konačnim stopama rasta (λ), koje su iznosile 4% i 9% godišnje. Korišćenjem podataka o odstrelu i konačnoj stopi rasta populacije, pod pretpostavkom da godišnji prirast populacije dostiže 20% u odnosu na brojnost jelena na kraju lovne sezone, izračunata je verovatna brojnost populacija. Proračun je pokazao da, u zavisnosti od dela terena, brojnost populacija je bila viša za 2 do 3 faktora u odnosu na procene lovaca i da je gustina populacije varirala od 8,7 do 106,5 grla / 1000 ha šume. Procenjena gustina populacija jelenske divljači u ispitivanom području je zbog toga bila viša za 139% u odnosu na zvanične podatke, brojnost jedinki je procenjena na 24,4 hiljade, odnosno 49,5 jedinki/ 1000 hektara šume. Predloženo je da se gustina jelenske divljači smanji na 35 jedinki/1000 ha kroz povećanje obima odstrela do 27% od ukupne brojnosti populacije pred početak lovne sezone.

Ključne reči: prebrojavanje populacije, lovačka statistika, konačna stopa rasta populacija, potecenjivanje brojnosti jelenske divljači

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**RED DEER (*Cervus elaphus* L.) MANAGEMENT IN FRUŠKA GORA
NATIONAL PARK (VOJVODINA)**

Gačić D.P.,¹ Danilović M.¹, Zubić G.², Cupara D.³

Summary: This paper presents the results of settlement and management of red deer in Fruška gora special-purpose hunting ground and National Park (Vojvodina) in submontane mixed broadleaf forests that were once part of its natural range. The total hunting ground area is 25,518 ha (105-539 m a.s.l.). In February 2009, red deer originating from Hungary (Kapošvar) were settled in the central area of the National Park in a place called Ravne (5♂ + 31♀), where an enclosed shelter area of about 100 ha had previously been established. The main goals of red deer settling in the area of Fruška Gora mountain were to establish a new viable free-ranging population which enables normal hunting management and ensure long-term economic benefit for the local community. The analysis is based on data from the planning documents of the PE “Fruška Gora National Park”, as well as on the basis of 70 discarded antlers measured according to the CIC formula and collected during a five year period (2010-2014). A total of three infrared sensor cameras (Dörr SnapShot / Mobil black 5.1) were placed at five locations from 1st December 2013 to 30th April 2014, and more than 10,000 JPEG images were saved. The results of measurement and analysis of discarded antlers indicate a high quality and good development of red deer males (2-6 years). A regular use of digital game cameras in several feeding sites enabled quick improvement of management and additional protection of the red deer. In addition, a number of other animal species which are important for hunting management were recorded – roe deer, wild boar, brown hare, fox and badger. In the spring of 2014, the estimated number of red deer in the open part of the hunting ground Fruška Gora National Park was about 100 specimens (45♂ + 55♀). According to the criteria for the assessment of reintroduction success, the settlement of red deer in the Fruška Gora National Park can so far be assessed as successful.

Key words: red deer, management, reintroduction, Vojvodina

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**GAZDOVANJE JELENOM (*Cervus elaphus* L.) U NACIONALNOM
PARKU FRUŠKA GORA (VOJVODINA)**

Gačić D.P.,¹ Danilović M.¹, Zubić G.², Cupara D.³

Sažetak: U radu su prikazani rezultati naseljavanja i gazdovanja jelenskom divljači u lovištu posebne namene i Nacionalnom parku Fruška gora (Vojvodina), u brdskim mešovitim šumama lišćara koje su nekada bile deo njenog prirodnog areala. Ukupna površina lovišta je 25,518 ha, a nadmorska visina od 105-539 m. Jelenska divljač poreklom iz Mađarske (Kapošvar) u februaru 2009. godine naseljena je u centralno područje nacionalnog parka na mestu zvanom Ravne (5♂ + 31♀), gde je prethodno osnovano ograđeno prihvatilište površine oko 100 ha. Osnovni ciljevi naseljavanja jelenske divljači na područje Fruške gore su formiranje nove vijabilne populacije koja omogućuje normalno lovno gazdovanje i obezbeđuje dugoročnu ekonomsku dobit za lokalno stanovništvo. Analiza je izvršena na osnovu podataka iz planskih dokumenata JP "Nacionalni park Fruška gora", kao i na osnovu 70 odbačenih grana parogova merenih po CIC formuli i kolektiranih tokom pet godina (2010-2014). Tri digitalne kamere (Dörr SnapShot / Mobil black 5.1) postavljane su na pet lokaliteta u periodu 1. XII 2013 - 30. IV 2014, i više od 10.000 JPEG slika je zabeleženo. Rezultati merenja i analize odbačenih grana parogova ukazuju na visok kvalitet i dobar razvoj muških jedinki (starost 2-6 godina). Redovna upotreba digitalnih kamera na nekoliko hranilišta omogućila je da se tokom kratkog perioda poboljša gazdovanje i dodatno zaštititi jelenska divljač. Takođe, evidentiran je veći broj drugih životinjskih vrsta važnih za lovno gazdovanje – srna, divlja svinja, zec, lisica i jazavac. U proleće 2014. godine, procenjena brojnost jelenske divljači u otvorenom delu lovišta Nacionalni park Fruška gora bila je oko 100 jedinki (45♂ + 55♀). Prema kriterijumima za ocenjivanje uspeha reintrodukcije, dosadašnje naseljavanje jelenske divljači u Nacionalnom parku Fruška gora može da se oceni kao uspešno.

Ključne reči: jelen, gazdovanje, reintrodukcija, Vojvodina

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REPRODUCTIVE POTENTIAL OF ROE DEER IN SLOVENIA

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Summary: European roe deer (*Capreolus capreolus* L.) is the most important game species in majority of European countries, including Slovenia. Therefore, it is crucial to perform an effective management of this species, which should be based on the knowledge on its population dynamic. Systematic research on reproductive potential (e.g. fertility and potential litter sizes) of roe deer in Slovenia began in 2013. Reproductive organs (uteri with ovaries) of culled roe deer females, i.e. adult does (n = 392) and yearlings (n = 82), were sampled in 45 hunting grounds all around Slovenia during the hunting season, from 1 September to 31 December 2013. Fertility was determined by the presence of corpora lutea in ovaries, and potential litter size by counting their numbers. Results confirmed high fertility of roe deer females in Slovenia. Corpora lutea were present in ovaries of all except two adult does, and only 15.9% of yearlings was infertile, all of them in poor body condition (undressed body mass <11 kg, i.e. without abdominal content, but with head and legs retained). Potential litter size (number of corpora lutea in ovaries) was primarily influenced by doe body mass and age. Mean number of corpora lutea was 1.84 in adult does, and 1.20 in yearlings, respectively. Body mass has a strong positive impact on the potential litter size in both age classes. However, yearlings (primiparous does) perform much higher variability in reproductive potential (i.e. all individuals <10 kg were without any corpus luteum, and all individual >18 kg had 2 corpora lutea). This has to be taken into account when making management decisions. Indeed, particularly selective culling of yearlings in poor condition, i.e. with low body mass, and preserving of heavier individuals, can have a significant impact on fawn production, and hence also on the reproduction of roe deer in the following year(s).

Key words: Roe deer, reproductive potential, doe fertility, corpus luteum

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**FILOGEOGRAFIJA EVROPSKOG SRNDAĆA I HIBRIDIZACIJA SA
SIBIRSKIM SRNDAĆEM U CENTRALNOJ I ISTOČNOJ EVROPI – UVOD U
PROJEKAT**

Plis K.¹, Niedziałkowska M.¹, Jędrzejewska B.¹

Sažetak: Mnogi faktori oblikuju genetički diverzitet prirodnih populacija različitih vrsta. Jednu od glavnih uloga u oblikovanju genetičke strukture populacija sisara Evrope imala su ledena doba. Postoje tri glavne mtDNK linije (zapadna, centralna i istočna) srndaća *Capreolus capreolus* u Evropi. Podaci o genetičkom diverzitetu srndaća istočnog dela kontinenta su nepotpuni. Brojni podaci ukazuju na postojanje velikih područja u istočnoj Evropi sa pogodnim uslovima za različite vrste drveća, biljaka i životinja u toku poslednjeg glacijalnog maksimuma (LGM). Cilj ovog rada jeste da se ustanovi lokalizacija istočnog LGM refugijuma i da se rekonstruišu postglacijalni ekspanzivni putevi srndaća. Našplan je da u studiju uključimo uzorke sakupljene u centralnoj, severnoj i istočnoj Evropi. Na osnovu podataka genetičke studije našeg tima sprovedene u populacijama severno-istočne Poljske, većina detektovanih haplotipova pripadala je haplogrupi centrane Evrope, jedan haplotip (H9) pripadao je istočnoj liniji haplotipova, dok je jedan haplotip (H3) genetički bio veoma udaljen od svih prethodno publikovanih haplotipova. Moguće je da postoji bar još jedna do sada neidentifikovana nova genetička linija Evropskog srndaća u severo-istočnom delu kontinenta. Pored prirodnih procesa, kao što je postglacijalna ekspanzija, uticaj čoveka, naročito translokacija koje su se dešavale u prošlosti, oblikovao je genetički diverzitet ungulate. U našoj studiji srndaća u severo-istočnoj Poljskoj, polovina je posedovala haplotipove Sibirskog srndaća *Capreolus pygargus* što je verovatno posledica translokacija Sibirskog srndaća u Białowieża Primeval šume u kasnom period XIX veka. Jedan od ciljeva našeg projekta je da se utvrdi stepen hibridizacije ove dve vrste u centralnoj i istočnoj Evropi i da se otkrije da li je hibridizacija posledica translokacija ili introgresije kao dela prirodnog procesa.

Cljučne reči: mikrosateliti, mtDNK, hibridizacija, populaciona genetika, protok gena.

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DETERMINATION OF DAMAGES CAUSED BY DEER GAME IN THE AREA OF MOSLAVAČKA GORA (MIDDLE CROATIA)

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Summary: Damages caused by deer game on forest habitats makes permanent and big problem, as well as in many European countries, as well in Croatia. Researches on this topic in Croatia were done occasionally, without systematic monitoring of impact and intensity of damage on forest stands. Experimental determination of deer damage was done in 2012, in the middle part of Moslavačka gora mountain, within the hunting ground VII/15 “Western Garjevica” (surface 25 779 ha). Field surveys were performed on selected experimental plots with total surface of 584 ha. The composition of dendroflora, number of trees, diameter breast high and tree age were determined on each plot. Data were collected according to methodology for forest management and inventory. Total of 198 271 trees has been measured, of which 47 180 was damaged, and 151 091 undamaged. In the forest stands damages are permanently present because man with its mode of management changed and imposed living conditions for deer game. Throughout years of forest management and practice at Moslavačka gora, occurrence and intensity of damages by deer game did not increased, but slightly declined for 0.4% in last twenty years. Regulations of the hunting ground and proper management by creating surface for pasture, sufficient and quality food and feeding sources facilitate setting up of balance between forest management and size of red deer population in the hunting ground.

Key words: damage, red deer, hunting ground, Moslavačka gora, Croatia

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**PROCENA ŠTETA OD JELENSKE DIVLJAČI NA PODRUČJU
MOSLAVAČKE GORE (SREDIŠNJA HRVATSKA)**

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Sažetak: Štete od jelenske divljači na šumskim stanštima danas su stalan i veliki problem, kako u državama Europe, tako i u Republici Hrvatskoj. Istraživanja ovog problema u Hrvatskoj su rađena povremeno, bez sistematskog praćenja uticaja i veličine štete. Pokusna procena šteta od jelenske divljači napravljena je u 2012. godini, u središnjem delu Moslavačke gore, u lovištu VII/15 "Zapadna Garjevica" čija je površina 25 779 ha. Terenski rad obavljen je na odabranim pokusnim plohama, s ukupnom površinom od 584 ha. Na svakoj pokusnoj plohi utvrđen je sastav dendroflоре, te broj stabala, prsni promer stabla i njegova starost. Podaci su prikupljeni primenom metodologije za uređivanje i inventarisanje šuma. Izmereno je ukupno 198 271 stabala, od kojih je 47 180 oštećeno, a 151 091 neoštećeno. Štete su stalno prisutne u šumskim sastojinama jer je čovek svojim načinom gazdovanja izmenio i nametnuo uslove za život jelenske divljači u staništu. Kroz godine praktičnog gazdovanja šumskim sastojinama na Moslavačkoj gori, nije došlo do jače pojave i intenziteta šteta od jelenske divljači, već je u prošlih dvadeset godina primećen lagani pad od 0,4 %. Uređenje lovišta i pravilno gazdovanje, formiranje pašnjačkih površina, obezbeđena kvalitetna prihrana i prehrana, doprinosi uspostavi ravnoteže između gazdovanja šumom i veličine populacije jelenske divljači.

Ključne reči: šteta, jelen obični, lovište, Moslavačka gora, Hrvatska

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INTEGRATION OF INTRODUCED MOUFLONS WITH THE LOCAL POPULATION IN THE SUDETY MOUNTAINS

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Summary: Research were carried out in Sowie Mountains that are located in central part of Sudety Mountains (South-western Poland). In 1902, 5 muflons *Ovis aries musimon* were brought from Slovakia into this region. In the next years there was an increase in population number until it reached 778 animals in 1995. Changes in not proper development of horns have been noticed for a long time. The older the males were the more curved horns they had, which eventually started to stab into the animal's neck. This process eliminated older animals and it was suggested that inbreeding it. In order to increase genetic variability it was decided to introduce more mouflons from Slovakia and Czech Republic. Between 2002-2004 76 mouflons were bought and placed to reproduce in two enclosures located in Bielawa and Jemna. In June 2006 mouflons from both enclosures (n= 177) were released. These were 59 males, 79 females and 40 lambs. All released animals were given ear tags and 10 females and 10 males got radio collars produced by Televilt. In the following years location of animals was confirmed through telemetry receivers. The results suggest that released mouflons colonized the area of 850 ha in enclosure Bielawa and 690 ha in enclosure Jemna. The animals were located max. 1.0 km - 3.1 km from the enclosures apart from one male that was found 9.1 km away from the farms. The average home range of males was 222 ha whereas for females it was 175 ha. After 4 years 19 out of 20 animals were still alive. The forest area in Gory Sowie that is inhabited by local population of mouflons is 15 800 ha. The degree of integration of released animals with the local mouflons was low as they occupied only 9,7% of range distribution of local population. It is possible that colonization of bigger areas took place through progeny of introduced animals. It will be clear within next 2-3 years if introduction of mouflons gave the expected results.

Key words: mouflon, southwestern Poland, introduction, home range, dispersal, radio tracking

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INTEGRACIJA INTRODUKOVANOG MUFLONA SA LOKALNOM POPULACIJOM U SUDETSKIM PLANINAMA

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Sažetak: Istraživanje je sprovedeno u Sowie planinama koje se nalaze u centralnom delu Sudetskih planina (jugozapadna Poljska). Godine 1902, 5 muflona *Ovis aries* musimon preneto je iz Slovačke u ovaj region. U sledećim godinama došlo je do povećanja brojnosti populacije do 778 jedinki 1995. godine. Promene u normalnom razvoju rogova primećene su u toku godina. Što su mužjaci bili stariji to su imali zakrivljenije rogove, in a kraju bi se oni zabadali u vrat životinja. Ovaj process doveo je do eliminacije starijih mužjaka i smatra se da je u pitanju posledica inbridinga (ukrštanja u srodstvu). Da bi se povećala genetička varijabilnost odlučeno je da se uvede još jedinki iz populacija u Slovačkoj i Češkoj. U period 2002-2004 76 muflona je uneto, i to u dva okruga Bielawa i Jemna koja su ograđena. Juna 2006 godine mufloni iz oba regiona (n=177) su oslobođeni. Ukupno je bilo 59 mužjaka, 79 ženki i 40 mladunaca. Sve puštene životinje bile su obeležene ušnim priveskom i 10 mužjaka i 10 ženki ogrlicom sa radioodašiljačem proizvođača Televilt. U nerednom period jedinke su praćene preko odašiljača. Rezultati pokazuju da su oslobođeni mufloni zauzeli područje od 850ha u okrugu Bielawa i 690ha u okrugu Jemna. Životinje su se nalazile na maksimalnoj udaljenosti od 1.0km-3.1km od ograđenog dela izuzev jednog mužjaka koji se nalazio na 9.1km od farme. prosečna veličina oblasti kretanja bila je 222ha za mužjake, odnosno 175ha za ženke. Nakon 4 godine 19 od 20 životinja je preživelo. Šumsko područje Gory Sowie koje je naseljeno lokalnom populacijom muflona ima 15 800ha. Stopa integracije introdukovanih muflona bila je niska obzirom da koriste samo 9.7% teritorije lokalne populacije. Moguće je da će kolonizacije veće teritorije biti od strane potomstva. U naredne dve do tri godine imaćemo krajnje rezultate da li je introdukcija muflona dala očekivane rezultate.

Ključne reči: muflon, jugozapadna Poljska, introdukcija, prirodni areal, disperzija, radiopraćenje

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HUNTING OF WILD BOAR IN SOUTHEAST EUROPE

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Summary: Population of wild boar on the territory of Southeastern Europe is growing year after year. That is attributed to following: climate changes, disrupted yearly mating dynamics, lack of predators (bear, wolf, lynx), negligent and abandoned agricultural land, reduced usage of self-made wood products, weakened interest for living and developing rural areas, increased migration of population, abandoned army objects and areas, and low density of human population.

Wild boar mainly resides in lowland areas where there is enough humidity, but also in hilly and mountains areas. Since it is a omnivore it always finds enough food throughout the year. In out of vegetation period hunters supplementary feed the population by which they keep them in certain territories.

Numerical state of wild boar is different by countries and regions, but the population behavior is similar in almost all territory of southeast Europe, from Black Sea to Adriatic, as well as on the territory of former Pannonian Sea. In this territory around 150.000 individuals/year of wild boar are being hunted down. Numbers of hunted wild boar are increasing year after year.

Hunting management is entrusted to hunters, physical or legal entity, hunting associations or organizations (NGO). Management is based on Hunting management plan and annual plans.

Interest for wild boar is big, for the hunt itself, but also for the trophy and meat. Hunting sow and younglings is forbidden certain part of year, but for boar, pig and yearlings hunting is allowed throughout the year.

Since wild boar is exceptionally active and movable in its search for food it travels great distances. In time of grain and fruit maturation it visits farms and orchards and inflicts great damages to crops and fruits. Biggest damages are made in farming cultures. For that reason hunters in some countries pay claimants estimated reimbursements, which are due to the volume of damage quite high. Part of potentially endangered farming territories are enclosed by electrical fences.

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IZLOV DIVLJIH SVINJA U JUGOISTOČNOJ EUROPI

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Sažetak: Populacija divlje svinje na prostorima jugoistočne Evrope sve je veća iz godine u godinu. To se pripisuje sledećim: klimatskim promenama, poremećenoj godišnjoj dinamici parenja, nedostatku predatora (medved, vuk, ris), zapuštenim i napuštenim poljoprivrednim zemljištem, smanjenim korištenjem samoizrađenih drvnih proizvoda, slabim interesom življenja i razvoja ruralnih područja, povećanom migracijom same populacije, napuštenim vojnim objektima i prostorima, te niskom gustoćom ljudske naseljenosti.

Divlja svinja najviše obitava u nizijskim delovima gde ima dosta vlage, ali takođe i u brdskim i poluplaninskim delovima. Kako je svaštojed uvek pronalazi dovoljno hrane tokom cele godine. U periodima bez vegetacije lovačka udruženja prihranjuju populaciju čime ih zadržavaju na određenoj teritoriji.

Brojno stanje divlje svinje je različito po državama i regijama, ali je ponašanje populacije slično na gotovo celoj teritoriji jugoistočne Evrope, od Crnog do Jadranskog mora, kao i na području nekadašnjeg panonskog mora. Na tom prostoru prosečno se izlovi oko 150.000 grla divlje svinje godišnje. Broj izlovljenih divljih svinja se povećava iz godine u godinu.

Gazdovanje je povereno korisnicima lovišta, fizičkim ili pravnim licima, lovačkim udruženjima ili društvima (NVO). Gazduje se na osnovu lovne osnove i godišnjeg plana gazdovanja. Interes za divljom svinjom je velik, kako zbog samog lova, tako i trofeja i mesa. Deo godine zabranjen je lov na krmače i mlade, ali na veprove, prasad i nazimad lov je dozvoljen tokom cele godine.

Kako je izuzetno aktivna i pokretljiva u potrazi za hranom divlja svinja prelazi velike udaljenosti. U vreme dospevanja žitarica i voćaka posjećuje ratarske i voćarske površine čime nanosi velike štete usevima i plodovima. Najveće štete nastaju na ratarskim kulturama. Iz tog razloga korisnicima lovišta u nekim državama plaćaju oštećenima procenjene naknade, koje su zbog obima štete vrlo

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REPRODUCTIVE PARAMETERS OF FARMED BROWN HARE (*LEPUS EUROPAEUS*) FOR RESTOCKING PURPOSES

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Summary: The population of European brown hare (*Lepus europaeus*) declined dramatically last decades in Slovakia. In many areas, originally with high density of hares, these are almost absent. Improving of the habitat is one of the main tasks for maintaining of hare populations. To increase the population density, we examined the hare farming for restocking purposes. Hares were kept in cages in couples all over the year. Leverets were weaned at the age of 28 days. During three consecutive years, 11.05 leverets were born and 7.06 leverets were weaned per 1 fertile female in average. The losses were 29.3 % (dead born and mortality up to weaning). We registered 21.5 % of couples having no offspring (due to various reasons). Average number of leverets in the litter was 2.57; average number of litters was 4.32 per fertile female. Hare does are able to have up to 8 litters in the year (due to superfoetation), the highest number of weaned leverets from one female in one year was 20. The adaptation of hares to the nature conditions is very important role. Hares for releasing were gradually fed with green fodder and after 2 weeks were released as groups with sex ratio 1:1 into enclosures offering diverse composition of green food. The adaptation improves the musculature of hares (average weight gain after adaptation was 0.95 kg and prepares the animals to natural food. After 6 weeks the hares are prepared for restocking purposes. The precondition for releasing success is the improvement of habitat.

Key words: brown hare, *Lepus europaeus*, farming, reproduction, adaptation for restocking

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REPRODUKTIVNI PARAMETRI VEŠTAČKI GAJENOG ZECA (*LEPUS EUROPAEUS*) U SVRHU OBNOVE FONDA

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Sažetak: Populacija evropskog zeca (*Lepus europaeus*) u Slovačkoj dramatično opada u poslednjoj dekadi. U mnogim oblastima, koja su prethodno beležila visoku brojnost zeca, sada se gotovo odsutan. Poboljšavanje stanišnih uslova je jedan od glavnih zadataka za održivost populacije zeca. Zbog povećanja brojnosti populacije, ispitali smo mogućnost veštačke proizvodnje zeca u svrhu obnove fonda. Zečevi u parovima su drđani u kavezima tokom godine. Zečiči su zalučeni sa starošću od 28 dana. Tokom tri uzastopne godine prosečno je rođeno 11,05 zečića a 7,06 je zalučeno po jednoj priplodnoj ženki. Gubici su iznosili 29,3% (mrtvorodeni, i uginuća do zalučenja). Zabeležili smo da 21,5% parova nije imalo potomstvo (zbog različitih razloga). Prosečan broj zečića u leglu je bio 2,57, prosečan broj legala po oplodenoj ženki je bio 4,32 po oplodenoj ženki. Zečevi su u mogućnosti da imaju preko 8 legala u godini (zbog superfetacije), najveći broj zalučenih zečića od jedne ženke u u jednoj godini je bio 20. Adaptacija zeca na prirodne uslove je veoma važan korak. Zečevi koji se ispuštaju su hranjeni postepeno svežom zelenom hranom, i nakon dve nedelje su ispušteni u grupama sa odnosom polova 1:1, u ograđeno područje gde se nalazila zelena hrana različitog sastava. Prilagođavanjem u ograđenom prostoru razvija se muskulatura zeca (prosečan prirast mase nakon perioda adaptacije je bio 0,95 kg) i na taj način se životinja priprema za hranu iz prirode. Nakon 6 nedelja zečevi su spremni za ispuštanje u prirodu u svrhu popune brojnosti. Preduslov za uspešno ispuštanje je poboljšanje uslova sredine, gde se ispuštanje vrši.

Ključne reči: zec, , *Lepus europaeus*, veštačka proizvodnja, reprodukcija, adaptacija

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**CYCLICITY OF LONG-TERM ABUNDANCE DYNAMICS IN
POPULATIONS OF LEPUS TIMIDUS IN TRANSBAIKAL REGION**

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Summary: White hare (*Lepus timidus*, L) is popular game animals as well as traditional object of abundance dynamics studying. This specie's cyclicity of abundance changes does not admit of doubt. Nonetheless there are no special studies devoted to the measuring of cycles of dynamics. Such cycles were assessed visually via graphics of long-term fluctuations of abundance of White hare or via quantity of furs. The aim of our research was the analysis of chronoecological characteristics of population abundance dynamics of White hare in Transbaikal region. We tried to solve the following tasks: to analyse abundance course of White hare in different districts, to build spectra of rhythms for each district, to count periods and strengths of periodical components in abundance dynamics in each district, to compare the spectra of rhythms of abundance dynamics of White hare for clarification population variability of this indicator. We used data on acquisition of White hare furs in 12 districts of Transbaikal region for the same 19 years period (1971-89). We compared images of abundance dynamics of specie in different districts situated on the timescale (chronograms). Moreover we built frequency spectrum of abundance rhythms for abundance changes in every district and we also counted characteristics of every rhythm (period in years and strength in spectral density units). All the data for abundance dynamics rhythms of White hare available for the region was split into two unequal groups. The biggest one includes populations with the main abundance dynamics rhythm which has period of 15-17 years. The second group which includes only 4 districts has main and the strongest population cycle of 20-25 years. The first group of populations synchronizes with 15-17 years rhythm of magnetic field of the Earth while the second one – with the Earth's rhythm with the period of 20-22 years.

Key words: White hare populations, cyclisity of abundance, Transbaikal region

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CIKLIČNOST DUGOROČNE DINAMIKE BROJNOSTI U POPULACIJI LEPUS TIMIDUS U TRANSBAJKALSKOM REGIONU

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Sažetak: Polarni zec (*Lepus timidus*, L.) predstavlja popularnu divljač kao i tradicionalan objekat za ispitivanje dinamike brojnosti. Cikličnost u promeni brojnosti se bez sumnje prisutna ne dovodi u pitanje. Ipak postoje posebne studije posvećenje utvrđivanju dinamike u ciklusima. Ovi ciklusi su vizuelno ocenjeni preko grafikona gde su prikazane dugoročne fluktuacije brojnosti polarnog zeca ili preko količine krzna ulovljenih zečeva. Cilj našeg istraživanja je bila analiza hrono ekoloških karakteristika zastupljenosti i dinamike populacije polarnog zeca u Transbajkalskom regionu. Pokušali smo da rešimo sledeće zadatke: da analiziramo pravac po pitanju dinamike brojnosti u različitim okruzima, da se izradi spektar ritma za svaki okrug, da se broje izbroje periodi i jačine periodičnih komponenti dinamike brojnosti svakog okruga, da se uporede spektri ritmičnosti dinamike brojnosti polarnog zeca za razjašnjenje sa stanovišta varijabilnosti populacije kao pokazatelja. Koristili smo podatke o proizvedenom krznu polarnog zeca u 12 okruga Transbajkalskog regiona tokom devetnajstogodišnjeg perioda (1971-89). Uporedili smo slike brojnosti i dinamike u različitim okruzima, na vremenskoj liniji. Pored toga iredili smo frekvencijski spektar, brojnosti ritma za promenu brojnosti u svakom okruzgu a isto tako smo brojali i karakteristike za svakim ritam (period u godinama i snage spektralnih jedinica). Svi podaci za brojnost populacije polarnog zeca iz svakog regiona su podeljeni u dve nejednake grupe. Veća predstavlja populaciju sa glavnim ritmom dinamike populacije za period 15-17 godina. Druga grupa koja obuhvata samo 4 okruga ima glavni i najjači populacioni ciklus od 20-25 godina. Prva grupa populacije je sinhronizovana sa 15-17 godišnjim ritmom magnetnog polja Zemlje, dok je druga grupa u ritmu Zemlje na period 20-22 godine.

Ključne reči: populacija polarnog zeca, cikličnost brojnosti, Transbajkalski region

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ANALYSIS OF THE KEY FACTOR OF GREY PARTRIDGES' MORTALITY

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Summary: This paper presents the research results of partial mortality in three major periods of the annual life cycle and their impact on overall mortality in populations of partridges, as an essential attribute of the population dynamics of each species, using the method of analysis of key factors of mortality.

The studies were conducted in the period 2007 - 2014 at an area of 450 ha in the small game hunting ground "Trubarevo", managed by the Faculty of Forestry for over 60 years, located in the southeastern part of Skoplje and bordered by suburbs and villages connected with the city, as well as with the most densely populated municipality in the city.

Data collection was performed by complete census, more accurately, by observing of population's strength (in terms of number) at least three times a week. Spring density, i.e. the number of isolated pairs was determined for the period 01.03. - 15.03., and the autumn density – after collection of the most of the crops and the completion of the morphological development of the raised youth, that is, from 20.09. - 10.10. every year. The size of the population after the end of the hunting season was determined in the period 15.12. - 31.12.

The results indicate that the key factor in the partridges' population dynamics is a variable category in different time periods. Despite the undoubtedly great influence of the chick survival rates in the first weeks of life on the total mortality, the losses in the winter very often are of essential importance for the changes in the partridges' population density, especially in extremely adverse weather conditions.

Key words: Grey partridge, mortality, key factor

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**FILOGEOGRAFIJA EVROPSKOG SRNDAČA I HIBRIDIZACIJA SA
SIBIRSKIM SRNDAČEM U CENTRALNOJ I ISTOČNOJ EVROPI – UVOD U
PROJEKAT**

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Sažetak: U radu su prezentirani rezultati istraživanja parcijalnih mortaliteta u tri najznačajnija perioda godišnjeg životnog ciklusa i njihov uticaj na ukupne gubitke u populacijama poljskih jarebica, kao suštinskom atributu populacione dinamike svake životinjske vrste, primenom metoda analize ključnog faktora mortaliteta.

Istraživanja su vršena u periodu 2007 – 2014 godine na površini od 450 ha u delu lovišta za sitnu divljač „Trubarevo“, kojim preko 60 godina gazduje Šumarski fakultet, lociranog u jugoistočnom delu priiferije grada i oivičenog prigradskim naseljima i selima spojenim sa gradom, kao i najgušće naseljenom gradskom opštinom.

Prikupljanje podataka je vršeno celosnim prebrojavanjem, tačnije praćenjem brojnog stanja najmanje tri puta u toku nedelje. Prolećne gustine, odnosno broj izdvojenih parova je utvrđivan u periodu 01.03. – 15.03., a jesenje posle sakupljanja najvećeg dela letine i završenog morfološkog razvoja odgajenog podmlatka, odnosno od 20.09. do 10.10. svake godine. Brojnost populacije posle završetka lovne sezone je utvrđivana u periodu 15.12. - 31.12.

Dobijeni rezultati ukazuju da je ključni faktor u populacionoj dinamici poljskih jarebica promenljiva kategorija u različitim vremenskim periodima. I pored nesumnjivo velikog uticaja stepena preživljavanja pilića u prvim nedeljama života na ukupnu mortalitet, gubici u zimskom periodu veoma često imaju suštinski značaj u promenama gustina populacija poljskih jarebica, naročito u ekstremno nepovoljnim meteorološkim uslovima.

Ključne reči: poljska jarebica, mortalitet, ključni faktor

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ROCK PARTRIDGE (*ALECTORIS GRAECA*) MANAGEMENT IN REPUBLIC OF CROATIA

Grubešić, M.¹, Tomljanović, K.¹

Summary: Rock partridge is a native species of small game bird that is being managed by Hunting Act (NN 140/05 and 75/09) on the territory of Republic of Croatia. Partridge is spread in Croatia in the subcostal part and islands, it inhabits karst covered with weaker intersected shrub vegetation, pastures and low deciduous groves from sea level all the way to mountainous regions of south and west hill steeps of Primorje and Dalmatian hinter side and Istrian coast (Vidović, 1999). Based on central hunting records, 2900 beaks are yearly extracted by cull on the territory of Republic of Croatia. Recorded state of mother fund in spring of 2012/2013 amounted to around 5 000 beaks, while accrual was fairly low 3400 beaks. Geographically speaking partridge is spread throughout the entire coastal part; however over 90% of recorded mother fund is concentrated on the territory of three counties of north and middle Dalmatia. Achieved mother funds, and indirectly cull as well are currently under capacity that is being recommended (Grubešić i sur. 2011). This state is a result of multiple and intertwined negative influences. Partridge cull for previous year numbered to 85% of accrual. Stated cull should be skeptical taken into consideration, because cull is often expressed for the sake of compliance with legal forms and in reality are not realized. Reduced action can ensure population progress, however if you take into consideration that during the 1980s the numbers reached over 35 000 beaks, current state is in no way satisfactory and is hard to assume that it will be reached in the near future. Conducted research during the last two years are pointing to good growth if we observe individual pairs (families), but it is very hard to determine real losses caused by predators. Research directed to habitat analysis point to high percentage of dependence of partridge to previously burned areas, which suggests that the fire, unfortunately, is the only ameliorative action in sense of improving habitation and living conditions for partridge.

Key words: rock partridge, hunting management, habitat capacity, cull, mother fund

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**JAREBICA KAMENJARKA(ALECTORIS GRAECA) GAZDOVANJE U
REPUBLICI HRVATSKOJ**

Grubešić, M.¹, Tomljanović, K.¹

Sažetak: Jarebica kamenjarka grivna autohtona je vrsta sitne pernate divljači kojom se na osnovu Zakona o lovstvu (NN 140/05) i Zakona o izmjenama i dopunama Zakona o lovstvu (NN 75/09) gazduje u čitavom arealu na području Republike Hrvatske. Kamenjarka je u Hrvatskoj raširena na području čitavog priobalnog dela kao i na ostrvima, nastanjuje krške kamenjare obrasle slabijom ispresecanom grmolikom vegetacijom, pašnjake i niske listopadne šumarke od granice mora pa sve do planinskih predela južnih i zapadnih obronaka gornjeg primorskog i dalmatinskog zaleđa kao i istarskog priobalja (Vidović, 1999). Na osnovu lovne evidencije, godišnje se na području R. Hrvatske odstrelom i iznese ukupno 2.900 kljunova. Zabeleženo stanje matičnog fonda u proleće 2012/2013 iznosilo je nešto iznad 5.000 kljunova, dok je zabeleženi prirast poprilično nizak, 3400 kljunova. Geografski gledano kamenjarka je raširena u čitavom priobalnom pojasu, međutim preko 90% zabeleženog matičnog fonda skoncentrisano je na području tri županije severne i srednje Dalmacije. Ostvareni matični fondovi, a posredno i odstrel trenutno se nalaze ispod kapaciteta koje preporučuju Grubešić i sar. 2011. Takovo stanje rezultat je višebrojnih i međusobno isprepletenih negativnih uticaja. Odstrel kamenjarke za prethodnu godinu iznosio je 85% prirasta. Iskazani odstrel treba uzeti sa jednom određenom rezervom jer često se odstrel iskazuje radi zadovoljavanja zakonske forme, a da se u stvarnosti ne realizuje. Smanjeni zahvat može osigurati napredak populacije, međutim ako se uzme u obzir da je osamdesetih godina dvadesetog veka brojnost bila preko 35000 kljunova sadašnje stanje nikako ne zadovoljava i teško je za pretpostaviti da će u skorijoj budućnosti biti postignuto.

Ključne reči: jarebica kamenjarka grivna, lovno gazdovanje, kapacitet staništa, odstrel, matični fond

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**SURVIVAL OF SPRING RELEASED, HAND REARED COMMON
PHEASANTS (*PHASIANUS COLCHICUS COLCHICUS* L. 1758) AND
CHUKAR PARTRIDGES (*ALECTORIS CHUKAR*, E. GRAY, 1830) IN
NATURAL HABITATS IN BULGARIA**

Mihaylov, H.¹, Gruichev, G.¹, Stoyan Stoyano S.¹

Summary: Survival and adaptation in the wild of the farm game birds are the most important indicators for the game breeding success. Spring release of hand-reared Common pheasants (*Phasianus colchicus* L., 1758) and Chukar partridges (*Alectoris chukar* Gray, 1830) is a powerful tool to increase the breeding potential and the growth rate of population. However, the process is complicated and depends to a large extent on the preservation and development of birds' wild instincts, proper breeding and dispersal, habitat selection and the period of releasing. Survival of 20 Common pheasants and 49 Chukar partridges, spring released in natural habitats in Bulgaria, was estimated using radio-telemetry. Pheasants were released in March 2011 and Chukars – in February to May 2010. During the first eight weeks after release 80% of Pheasants and 88% of Chukars died. Chukars survival rates did not depend on the method of releasing. Pheasants and Chukars survival rates did not differ, but Pheasants dispersion was lower. The highest mortality rates occurred in the first 2 weeks after releasing.

Key words: Key words: survival rates, radio telemetry, farm birds, pheasant, chukar partridge

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**OPSTANAK, PROLEĆNOG ISPUŠTANJA VEŠTAČKI GAJENOG FAZANA
(PHASIANUS COLCHICUS COLCHICUS L. 1758) I ČUKAR JAREBICE
(ALECTORIS CHUKAR, E. GRAY, 1830) U PRIRODNIM STANIŠTIMA
BUGARSKE**

Mihaylov, H.¹, Gruichev, G.¹, Stoyan Stoyano S.¹

Sažetak: Opstanak i adaptacija veštački gajene pernate divljači na uslove u divljini je jedan od najvažnijih indikatora uspešnosti veštačkog odgoja ove vrste divljači. Prolećno ispuštanje veštački gajenog fazana (*Phasianus colchicus* L., 1758) i čukar jarebice (*Alectoris chukar* Gray, 1830) predstavlja moćan alat za povećanje odgajivačkog potencijala kao i stope porasta populacije. Međutim taj proces je komplikovan i utiče u velikoj meri na očuvanje divljih nagona ptica, pravilan rast i razvoj, izbor staništa i vreme ispuštanja. Opstanak 20 fazana i 49 čukar jarebica, nakon prolećnog ispuštanja u prirodna staništa Bugarske, praćen je korišćenjem radio telemetrije. Tokom prvih osam nedelja nakon ispuštanja 80% fazana i 88% čukar jarebica je uginulo. Stopa preživljavanja čukar jarebice ne zavisi od metoda ispuštanja. Stopa preživljavanja fazana i čukar jarebice se nije razlikovala, jedino je disperzija bila niža kod fazana. Najviša stopa smrtnosti se dogodila u prve dve nedelje nakon ispuštanja.

Ključne reči: stopa preživljavanja, radio telemetrija, veštački uzgoj, fazan, čukar jarebica.

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FIBER LEVEL OF NATURAL FEED IN STOMACH CONTENT OF BROWN HARE (*LEPUS EUROPAEUS*) FROM OPEN FIELDS OF AGRO-BIOTOPE

Beuković M.¹, Đorđević N.², Beuković D.¹

Summary: Disappearance of steppe as ideal habitat for brown hare, this species has been successfully adapted to agro biotope, or areas under large arable land. The hares prefer a habitat of open fields with hedgerows and woodlots near arable farmland, as they're herbivores and mainly eat wild herbs, grasses and agricultural crops. European hares can eat a lot of vegetation, rich in cellulose, which is part of the brown hares' grass-based diet, is difficult to digest in first time passing through digestive tract, which is monogastric. While lying in their forms during the day the hares pass soft droppings, which contain the undigested vegetation. They eat these soft pellets a process called coprophagy so they can properly digest their food and get the maximum nutrition from it. One of the quickest and easiest way to estimate the composition and quality of brown hare feed from open fields of agro-biotope is examining stomach contents of hunted animals. In our research samples of gastric contents of 115 brown hare were collected from eight different locations in Vojvodina, during the autumn hunting season 2012th. We analyzed the age of hunted animals and the fiber content in the stomach (NDF and ADF). The goal of this paper was to determinate fiber level in stomach content of brown hare from open fields of in Vojvodina. The NDF level was in range 28.45% to 29.86% depending of age, level of ADF also depended of age and it was 18.66% to 20.35%. Between age groups there is no statistical significant differences. The highest level of NDF was in up 1 year age old group of brown hare. It has been observed that the level of the ADF was increasing with aging. Correlation between NDF and ADF in the stomach contents of brown hare was positively correlated ($r = 0.70$) and can be assessed with moderate connection.

Key words: brown hare, NDF, ADF, stomach content, natural feed

The authors wish to express gratitude to the Ministry of education, science and technological development of the Republic of Serbia which financed these investigations within the project TR-31009

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NIVO VLAKANA IZ PRIRODNE HRANE U ŽELUDAČNOM SADRŽAJU ZECA (*LEPUS EUROPAEUS*) SA SLOBODNIH PODRUČJA AGROBIOTOPA

Beuković M.¹, Đorđević N.², Beuković D.¹,

Sažetak: Nestankom stepa koje su idealno stanište za zeca, ova vrsta se uspešno prilagodila agro biotopu, odnosno područja pod velikom obradivim površinama. Zečevi vole staništa otvorenih polja oivičenih rastinjem i šibljem, u blizini oranica, obzirom da su biljojedi i hrane se travom i oraničnim usevima. Evropski zec tokom ishrane konzumira dosta vegetacije, koja je bogata celulozom, koja kao sastavni deo ishrane zeca predstavlja teško svarljivu hranu prilikom prvog prolaska kroz digestivni trakt koji je monogastričan. Ležeći u logi tokom dana zec izbacuje izmet, koji sadrži nesvarenu vegetaciju. Konzumirajući izmet koji ima formu meke pelete (koprofagija) zečevi mogu u potpunosti da svare hranu i izvuku maksimalnu količinu hranljivih materija. Jedan od najbržih i najlakši način za procenu sastava i kvaliteta hranljive vrednosti prirodne hrane zeca je ispitivanje želudačnog sadržaja odstreljenih životinja. U našem istraživanju uzorci želudačnog sadržaja 115 zečeva su sakupljeni sa osam različitih lokaliteta u Vojvodini, tokom jesenje lovne sezone 2012. Analizirana je starost odstreljenih jedinki kao i sadržaj vlakana u želucu (NDF i ADF). Cilj ovog rada je da utvrdi nivo vlakana u želudačnom sadržaju sa otvorenih područja Vojvodine. Nivo NDF vlakana u zavisnosti od starosne dobi se kretao od 28,45 do 29,86%, dok se nivo ADF-a takođe u zavisnosti od starosne dobi kretao od 18,66-20,35%. Između starosnih grupa nisu utvrđene statistički značajne razlike. Najviši sadržaj NDF-a je bio kod jedinki starosti preko 1 godine. Uočeno je i da se nivo ADF povećavao sa starošću. Povezanost nivoa NDF-a i ADF-a u želudačnom sadržaju zečeva je u pozitivnoj korelaciji ($r=0,70$) i može se oceniti sa umerenom povezanošću.

Ključne reči: zec, NDF, ADF, želudačni sadržaj, prirodna hrana

Autori žele da izraze zahvalnost Ministarstvu obrazovanja, nauke i tehnološkog razvoja Republike Srbije, koje je finansira ova istraživanja u okviru projekta TR-31009

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**BALANCING OF REQUIREMENTS AND ANIMAL ORIGIN FEED
SUBSTITUTION, IN CONCENTRATE MIXTURE
FOR PHEASANT IN AVIARY**

Dorđević, N.¹, Popović, Z.¹, Dinić, B.¹, Beuković, D.², Beuković, M.²

Summary: Design of the chemical composition of the mixture for pheasants reared in aviaries is based on the quantitative expression of proteins, relative energy and protein with respect to modern standards (NRP, 1994), while a protein quality is partly ignored (practically are used the table values for the amino acid composition). Besides a review of the results, in practical examples, this paper presents the possibility of conceiving a mixture of concentrates with lower levels of protein, but with the appropriate ratio of amino acids. This can be done by rationalizing nutrition of pheasants reared in aviaries in both parents flock, and pheasants prepared to settle in the hunting grounds. In addition, at specific examples, is presented the opportunity for a complete substitution of animal origin feed (as the source of the limiting amino acid), which would simplify factory mixture production, in accordance with the Veterinary Law and the current Regulation on the quality of animal feed in Serbia. Using all animal origin feeds with the exception of milk and milk products, is prohibited in ruminant nutrition due to a risk of transmission and spread of the disease, bovine spongiform encephalopathy-BSE (mad cow disease), and it is very limited in the diet for non-ruminants (pigs and poultry), because it requires the existence of separate production lines in feed factories. Instead of these nutrients, in the diet of non-ruminants are used more often adequate replacements based on a combination of high-quality plant feed and synthetic amino acids, or a commercial substitute for fish meal. Thereby, an adequate chemical composition is achieved by the same or even a lower cost.

Key words: pheasants, aviaries, diet, proteins, amino acids, substitution.

The authors wish to express gratitude to the Ministry of education, science and technological development of the Republic of Serbia which financed these investigations within the project TR-31009

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BALANSIRANJE POTREBA I SUPSTITUCIJA HRANIVA ANIMALNOG POREKLA U SMEŠAMA KONCENTRATA ZA FAZANE U VOLIJERAMA

Đorđević, N.¹, Popović, Z.¹, Dinić, B.², Beuković, D.³, Beuković, M.³

Sažetak: Koncipiranje hemijskog sastava smeša za fazane gajene u volijerama bazira se na kvantitativnom izražavanju potreba u proteinima, odnosu energije i proteina i uz poštovanje savremenih normativa (NRP, 1994), dok se delom zanemaruje kvalitet proteina (u praksi se koriste tablične vrednosti za aminokiselinski sastav). Pored pregleda dosadašnjih rezultata, u konkretnim primerima u ovom radu, prikazana je mogućnost koncipiranja smeše koncentrata sa manjim nivoom proteina ali sa odgovarajućim odnosom aminokiselina. Time se može obaviti racionalizacija ishrane fazana u volijerama, kako matičnog jata, tako i fazančića koji se pripremaju za naseljavanje u lovišta. Osim toga, na konkretnim primerima je prikazana mogućnost za potpunu supstituciju hraniva animalnog porekla (kao izvora limitirajućih aminokiselina) što bi pojednostavilo fabričku izradu smeša, a u skladu sa Zakonom o veterini (2005) i Pravilnikom o kvalitetu hrane za životinje (2011), koji su trenutno aktuelni u Srbiji.

Korišćenje svih hraniva animalnog porekla, sa izuzetkom mleka i proizvoda prerade mleka, zabranjeno je u ishrani preživara zbog opasnosti prenošenja i širenja bolesti Bovine spongiform encephalopathy–BSE (kravlje ludilo), a veoma je ograničeno u ishrani nepreživara (svinja i živine), jer zahteva postojanje odvojenih linija u fabrikama hrane za životinje. Umesto ovih hraniva, u ishrani nepreživara sve se češće koriste adekvatne zamene na bazi kombinacije kvalitetnih hraniva biljnog porekla i sintetičkih aminokiselina, ili komercijalnih zamena za riblje brašno. Pri tome, postiže se adekvatan hemijski sastav, kao i slična ili čak niža cena.

Ključne reči: fazani, volijere, ishrana, proteini, aminokiseline, supstitucija.

Autori žele da izraze zahvalnost Ministarstvu obrazovanja, nauke i tehnološkog razvoja Republike Srbije, koje je finansira ova istraživanja u okviru projekta TR-31009

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VALIDATION OF AN ET-AAS METHOD FOR THE DETERMINATION OF LEAD AND CADMIUM IN LIVER SAMPLES OF HARE

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Summary: A rapid, sensitive, accurate and precise method for the determination of lead and cadmium in tissue samples of hare by Electro-thermal Atomic Absorption Spectrometry was validated. The main parameters evaluated in the validation were: linearity, accuracy, repeatability and within-laboratory reproducibility, detection and quantification limits. Measurement uncertainty was calculated. In particular, the results for limit of detection and limit of quantification were 4.26 and 12.90 µg/kg for lead while these values for cadmium were 2.32 and 7.04 µg/kg. Method showed good linearity with correlation coefficients of R²=0,997 for cadmium and R²=0,999 for lead. Accuracy was evaluated by spike recovery tests and it was performed for lead and cadmium in both, kidney and liver samples. Obtained recovery values were ranged from 81.6% to 107.0%. Repeatability and within-laboratory reproducibility were also evaluated for both elements in kidney and liver samples separately. Obtained values in both sample types and for each element, met the criteria of CV < 5% for repeatability and CV < 10% for within-laboratory reproducibility. Overall measure uncertainties were 33% for lead and 29% for cadmium. The results make evident that the procedure can be used as a method for the determination of lead and cadmium in liver and kidney samples of hare.

Key words: cadmium, ET-AAS , lead, brown hare, liver, validation

The authors wish to express gratitude to the Provincial Secretariat for Agriculture, Water Management and Forestry for the financial support of these investigations within the project "Biomonitoring of brown hare (Lepus europaeus P.) micropopulation potential in hunting grounds to the accumulation heavy metals in target tissue".

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**NIVO VLAKANA IZ PRIRODNE HRANE U ŽELUDAČNOM SADRŽAJU
ZECA (*LEPUS EUROPAEUS*) SA SLOBODNIH PODRUČJA AGROBIOTOPA**

Beuković M.¹, Dorđević N.², Beuković D.¹,

Sažetak: Izvršena je validacija Elektro-termalne atomske apsorpcione spektrometrija, koja je ocenjena kao Brz, pouzdan, tačan i precizan metod za određivanje olova i kadmijuma u uzorcima tkiva zeca. Glavni parametri u oceni validacije su: linearnost, tačnost, ponovljivost i unutar-laboratorije reproduktivnost, detekcija i kvantifikacija granice. Izračunata je i merna nesigurnost. Konkretno, rezultati za granice detekcije i granice kvantifikacije su 4,26 i 12,90 µg/kg za olovo, dok se ove vrednosti za kadmijum su 2,32 i 7,04 µg g / kg. Metod pokazao dobru linearnost sa koeficijentima korelacije $R^2 = 0.997$ za kadmijum i $R^2 = 0.999$ za olovo. Tačnost je ocenjen Spike testom ponovljivosti za olovo i kadmijum uzoracima jetre. Dobijene ponovljene vrednosti su u rasponu od 81,6% do 107,0%. Ponovljivost kao i unutar-laboratorijska reproduktivnost su procenjeni za oba elementa u uzorcima jetre odvojeno. Добијене вредности у узорцима и за сваки елемент, су испунили критеријуме из CV <5% за понављивост и ЦВ <10% за унутар-лабораторијску репродуктивност. Generalno неизвесnosti je bila 33% za olovo i 29% za kadmijum. Iz prikazanih Rezultata validacije jasno se vidi da se postupak može koristiti kao metod za određivanje olova i kadmijuma u uzorcima jetre zeca

Ključne reči: kadmijum, ET-AAS , olovo, zec jetra validacija

*Autori žele da izraze zahvalnost Pokrajinskom sekretarijatu za poljoprivredu vodoprivredu i šumarstvo, koje je finansira ova istraživanja u okviru projekta " Procena biomonitorskog potencijala mikropopulacija zeca (*Lepus europaeus p.*) u lovištima vojvodine na osnovu akumulacije teških metala u target tkivima"*

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GENETIC DIFFERENTIATION OF GREY WOLF POPULATION (CANIS LUPUS L.) FROM BALKAN AND CARPATHIANS

Bakan, J.¹, Lavadinović, V.², Popović, Z.³, Paule, L.¹

Summary: Genetic differentiation of grey wolf (*Canis lupus*) populations from Balkan (Serbia and Bulgaria) and the Western Carpathians was studied by means of using tissue and bone samples from legally hunted wolves. In total, 339 samples of tissues and bones and small number of faeces, blood and urine samples were used. Genotyping was based on 15 microsatellites of nuclear DNA. Genetic differentiation was studied using Bayesian approach (STRUCTURE software). Obtained results showed the differentiation between the Balkan and the Carpathian populations as well as between the Bulgarian population and both populations from Serbia and Slovakia. There are indications of migration towards west. Although these results are based on the nuclear markers, it would be advised to reanalyze the samples using mtDNA markers.

Key words: Carpathians, Balkan, genetic differentiation, *Canis lupus*

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**GENETIČKA DIFERENCIJACIJA POPULACIJA VUKOVA
(CANIS LUPUS L.) SA BALKANA I KARPATA**

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Sažetak: Genetska diferencijacija populacija vukova (*Canis lupus*) sa Balkana (Srbija i Bugarska) i Zapadnih Karpata je studirana korišćenjem uzoraka tkiva i kostiju od legalno odstreljenih jedinki. Ukupno je 339 uzoraka tkiva i kostiju korišćeno, kao i manji broj uzoraka izmeta, krvi i urina. Genotipiranje je bilo bazirano na 15 mikrosatelita nuklearne DNA. Genetska diferencijacija je studirana korišćenjem Bajezianovog pristupa (STRUCTURE software). Dobijeni rezultati ukazuju na diferencijaciju između Balkanske i Karpatske populacije, kao i između Bugarske populacije i populacija iz Srbije i Slovačke. Oni ukazuju na migracije ka zapadu. Iako su ovi rezultati zasnovani na nuklearnim markerima, bilo bi dobro da se ponovo analiziraju uzorci korišćenjem mtDNA markera.

Ključne reči: Karpati, Balkan, genetska diferencijacija, *Canis lupus*

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GENETIC VARIABILITY OF GREY WOLF (*Canis lupus*) POPULATION IN BOSNIA AND HERZEGOVINA

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Summary: Previous analyses of genetic diversity in grey wolf populations from Europe showed that grey wolves from the Balkans retained high portion of variability comparing to other European grey wolf populations. The main goal of this research was to determine genetic variability of grey wolf population from Bosnia and Herzegovina based on mtDNA control region sequence variability. Muscle tissue samples of 17 grey wolf individuals were collected. Total DNA was extracted and partial fragment of mitochondrial control region was amplified and sequenced. The final length of sequences in the dataset was 283bp, among which 10 were variable positions (9 parsimony informative sites and 1 singleton variable site). In total, four haplotypes were detected in grey wolf population from Bosnia and Herzegovina. Haplotype diversity was $h=0.625\pm0.083$, nucleotide diversity, $\pi=0.012$, while average number of nucleotide differences was $k=3.515$. One haplotype showed high frequency (52.9%), one intermediate frequency (35.3%) and two haplotypes were rare and detected only per one individual (5.9% each). Mismatch distribution analysis showed statistically significant deviation from the null hypothesis that the observed data fit the sudden expansion model ($Ssd=0.136$; $p=0.03$). We have found high genetic variability within analysed grey wolf population, as expected for the Dinaric-Balkan grey wolf populations, as compared with other European wolf populations. Detection of present genetic diversity and demographic history is important for determination of population structure and sustainable management of the population.

Key words: grey wolf, genetic variability, Bosnia and Herzegovina

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GENETIČKA VARIJABILNOST POPULACIJE VUKA (*Canis lupus*) U BOSNI I HERCEGOVINI

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Kratak uvod: Prethodne analize genetičke raznovrsnosti u populacijama sivog vuka Evrope su pokazale da sivi vukovi Balkana imaju visok nivo varijabilnosti u odnosu na ostale populacije sivog vuka u Evropi. Glavni cilj ovog istraživanja bila je determinacija genetičke varijabilnosti populacije sivog vuka iz Bosne i Hercegovine, na osnovu varijabilnosti sekvence kontrolnog regiona mtDNK.

Materijal i Metode: Sakupljeni su uzorci mišićnog tkiva 17 jedinki sivog vuka. Izolovana je ukupna DNK, i fragment mitohondrijalnog kontrolnog regiona je amplifikovan i sekvencioniran.

Rezultati: Konačna dužina ispitivanih sekvenci bila je 283bp, u okviru kojih je nađeno 10 varijabilnih pozicija (9 informativnih pozicija i 1 jedinstvena varijabilna pozicija). U populaciji sivog vuka iz Bosne i Hercegovine detektovana su ukupno četiri haplotipa. Jedan haplotip je pokazao visoku frekvenciju (52,9%), jedan srednju frekvenciju (35,3%), a dva haplotipa su jedinstveni i uočeni kod 2 jedinke (5,9% svaki). Diverzitet haplotipova je $h=0,625\pm0,083$, diverzitet nukleotida, $\pi=0,012$, dok je prosečan broj nukleotidnih razlika $k=3,515$. Mismatch analiza pokazala je statistički značajno odstupanje od nulte hipoteze po kojoj posmatrani podaci odgovaraju modelu nagle ekspanzije ($Ssd=0,136$; $p=0,03$). Uočena je visoka genetička raznovrsnost unutar analizirane populacije sivog vuka, što je i očekivano za populacije sivog vuka Dinarsko-Balkanskog regiona u poređenju sa ostalim evropskim populacijama sivog vuka. Detekcija prisutne genetičke raznovrsnosti i demografske istorije je važna za determinaciju populacione strukture i održivog upravljanja populacije.

Ključne reči: sivi vuk, genetička raznovrsnost, Bosna i Hercegovina.

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MITOCHONDRIAL DNA POLYMORPHISM IN POPULATION OF EUROPEAN ROE DEER (*CAPREOLUS CAPREOLUS*) FROM VOJVODINA

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Summary: Roe deer (*Capreolus capreolus*) populations from Serbia were previously genetically characterized based on allozyme and mtDNA sequence variability. Populations from Vojvodina were described as populations with high genetic diversity and higher inbreeding level. MtDNA diversity was higher in roe deer from Serbia, than elsewhere in Europe. In last decade lower fertility rate have been detected in roe deer populations from Vojvodina. Thus, the aim of this study was to explore genetic diversity of roe deer population from Vojvodina based on mtDNA polymorphism and to infer information on possible reduced genetic variability. In the present paper we present our first results on mtDNA polymorphism in roe deer population from Vojvodina. A fragment of 452bp mtDNA control region was successfully amplified for 12 roe deer individuals sampled in 2014 in Nova Crnja, Novo Miloševo and Novi Bečej hunting grounds and sequencing was performed. We observed a high genetic diversity in roe deer population from Vojvodina. Eight different haplotypes were detected. Haplotype diversity was $h=0.909\pm0.065$; nucleotide diversity $\pi=0.013$ and average number of nucleotide differences $k=5.955$. In total 17 polymorphic sites were found, among which 9 were parsimony informative. Mismatch analyses supported a pattern of demographic expansion ($S_{sd} = 0.044$, $p = 0.17$), as well as negative values of neutrality tests (Fu's $F_s = -0.588$, $p=0.201$; Tajima's $D = -0.250$, $p>0.10$). High genetic variability was detected in roe deer population from Vojvodina based on mitochondrial DNA sequence variability. Our preliminary results indicate that no decline of genetic diversity is present, comparing to previously published data. Furthermore, population expansion was registered. Nevertheless further studies with more variable genetic markers are needed to confirm this result and to gain more detail information on roe deer population structure.

Key words: mtDNA, roe deer, Vojvodina

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POLIMORFNOST MITOHONDRIJALNE DNK U POPULACIJI SRNDAĆA (*CAPREOLUS CAPREOLUS*) VOJVODINE

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Marković V.², Obreht D.¹, Ristić Z.²

Sažetak: Poulacije srndaća (*Capreolus capreolus*) Srbije su genetički karakterisane primenom analize alozima i sekvenci mtDNK. Populacije iz Vojvodine su označene kao populacije sa najvećim genetičkim diverzitetom ali i sa povišenom stopom inbridinga. Diverzitet mtDNK srndaća Srbije je najveći u poređenju sa svim populacijama Evrope. U poslednjoj deceniji registruje se opadanje fertilnosti u populacijama srndaća Vojvodine. Cilj ove studije je da se ispita genetički diverzitet srndaća u Vojvodini na osnovu polimorfности mtDNK i da se istraži potencijalno smanjenje genetičkog diverziteta. U ovom radu prikazani su prvi rezultati polimorfности mtDNK kod srndaća Vojvodine. Fragment sekvence kontrolnog regiona mtDNK dužine 452bp uspešno je amplifikovan i sekvenciran kod 12 jedinki izlovljenih u toku 2014 godine u lovištima Nova Crnja, Novo Miloševo i Novi Bečej. Uočen je visok genetički diverzitet u populaciji srndaća Vojvodine. Registrovano je osam haplotipova. Diverzitet haplotipova iznosio je $h=0,909\pm0,065$; diverzitet nukleotida $\pi=0,013$ i prosečan broj nukleotidnih razlika $k=5,955$. Ukupno je nađeno 17 polimorfni mesta, od kojih su 9 bili informativna mesta. Mismatch analiza pokazala je prisustvo demografske ekspanzije ($S_{sd} = 0,044$, $p = 0,17$), kao i negativne vrednosti testova neutralnosti ($F_u F_s = -0,588$, $p=0,201$; Tajima $D = -0,250$, $p>0,10$). Visok stepen genetičke varijabilnosti nađen je u populaciji srndaća Vojvodine na osnovu varijabilnosti mtDNK sekvenci. Preliminarni rezultati ukazuju da nije došlo do smanjenja genetičke varijabilnosti, u poređenju sa prethodnim istraživanjima. Registrovana je demografska ekspanzija populacije. Dalja istraživanja uz primenu visokovarijabilnih nuklearnih markera su neophodna radi potvrde rezultata is a ciljem dobijanja informacije o strukturi populacije.

Ključne reči: mtDNK, srndać, Vojvodina

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**PHYLOGEOGRAPHY OF EUROPEAN ROE DEER AND ITS
HYBRIDIZATION WITH SIBERIAN ROE DEER IN CENTRAL AND
EASTERN EUROPE – INTRODUCTION TO THE PROJECT**

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Summary: Many factors have an impact on the genetic diversity of contemporary living populations of different species. One of the main role in shaping genetic structure of mammals in Europe was played by the Quaternary Ice Ages. There are three main mtDNA lineages (western, central and eastern) of roe deer *Capreolus capreolus* recognized in Europe. The data concerning the genetic diversity of roe deer in eastern part of the continent are scarce. Numerous scientific data have confirmed the existence of large areas in eastern Europe with suitable conditions for many tree, plants and animal species during Last Glacial Maximum (LGM). The aims of our study are to establish the localization of eastern LGM refugia and to reconstruct the postglacial colonization routes of roe deer. We plan to include into our study samples of this species collected in central, northern and eastern Europe. According to the genetic study of roe deer performed by our team in the north-eastern Poland, most of the individuals which had mtDNA haplotypes of European roe deer clustered with the central lineage of the species, one haplotype (H9) clustered with the eastern lineage, and one (H3) was genetically very distinct from all lineages known from previous studies. It is possible that at least one new genetic lineage of European roe deer exists in the north-eastern part of the continent.

Except the natural processes such as e.g. postglacial expansion, also human intervention, especially translocations performed in the past, had the impact on the present genetic diversity of the ungulate species. In our study of European roe deer in the north-eastern Poland, about half of the mtDNA haplotypes belonged to Siberian roe deer *Capreolus pygargus* which is probably an effect of the translocation of the Siberian roe deer to Białowieża Primeval Forest in the late 19th century. One of the aims of the project is to determine the level and the range of hybridization between these two species in central and eastern Europe and to find out if this hybridization is an effect of the translocations or introgression caused by natural processes.

Key words: microsatellites, mtDNA, hybridization, population genetic, gene flow

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**FILOGEOGRAFIJA EVROPSKOG SRNDAĆA I HIBRIDIZACIJA SA
SIBIRSKIM SRNDAĆEM U CENTRALNOJ I ISTOČNOJ EVROPI – UVOD U
PROJEKAT**

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Sažetak: Mnogi faktori oblikuju genetički diverzitet prirodnih populacija različitih vrsta. Jednu od glavnih uloga u oblikovanju genetičke strukture populacija sisara Evrope imala su ledena doba. Postoje tri glavne mtDNK linije (zapadna, centralna i istočna) srndaća *Capreolus capreolus* u Evropi. Podaci o genetičkom diverzitetu srndaća istočnog dela kontinenta su nepotpuni. Brojni podaci ukazuju na postojanje velikih područja u istočnoj Evropi sa pogodnim uslovima za različite vrste drveća, biljaka i životinja u toku poslednjeg glacijalnog maksimuma (LGM). Cilj ovog rada jeste da se ustanovi lokalizacija istočnog LGM refugijuma i da se rekonstruišu postglacijalni ekspanzivni putevi srndaća. Našplan je da u studiju uključimo uzorke sakupljene u centralnoj, severnoj i istočnoj Evropi. Na osnovu podataka genetičke studije našeg tima sprovedene u populacijama severno-istočne Poljske, većina detektovanih haplotipova pripadala je haplogrupi centrane Evrope, jedan haplotip (H9) pripadao je istočnoj liniji haplotipova, dok je jedan hapotip (H3) genetički bio veoma udaljen od svih prethodno publikovanih haplotipova. Moguće je da postoji bar još jedna do sada neidentifikovana nova genetička linija Evropskog srndaća u severo-istočnom delu kontinenta. Pored prirodnih procesa, kao što je postglacijalna ekspanzija, uticaj čoveka, naročito translokacija koje su se dešavale u prošlosti, oblikovao je genetički diverzitet ungulate. U našoj studiji srndaća u severo-istočnoj Poljskoj, polovina je posedovala haplotipove Sibirskog srndaća *Capreolus pygargus* što je verovatno posledica translokacija Sibirskog srndaća u Białowieża Primeval šume u kasnom period XIX veka. Jedan od ciljeva našeg projekta je da se utvrdi stepen hibridizacije ove dve vrste u centralnoj i istočnoj Evropi id a se otkrije da li je hibridizacija posledica translokacija ili introgresije kao dela prirodnog procesa.

Cljučne reči: mikrosateliti, mtDNK, hibridizacija, populaciona genetika, protok gena.

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MITOCHONDRIAL DNA VARIATION IN ROE DEER POPULATION FROM LITHUANIA

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Summary: The current Lithuanian roe deer population is abundant and consisting of approximately 115,000 animals. Data on the genetic variability of roe deer in Lithuania is still sparse. The aim of this study was to assess the genetic status of roe deer in Lithuania using D-loop sequences analysis.

Materials and methods

Samples of 20 roe deer were collected from different Lithuania regions. Genomic DNA was extracted from small pieces of muscle tissue using a Genomic DNA Purification Kit. Amplification of the mitochondrial control region was performed using primers pairs: L-Pro and H-493. PCR amplification products of D-loop were purified by GeneJET Gel Extraction Kit and sequenced with BigDye® Terminator v3.1 Cycle Sequencing Kit, which run on 3130xl Genetic Analyzer. Sequences were aligned by the BioEdit 7.2.5 and MEGA 6 software, haplotypes were identified by DnaSP v.5 program. The 457 bp mtDNA control region sequence and 38 variable nucleotide sites were determined from 20 individuals. Comparative analysis of the data were performed using homologous mtDNA control region sequences uploaded in GenBank database. Six haplotypes and two haplogroups were identified in population of roe deer in Lithuania. Three haplotypes of them were unique and detected only in Lithuanian roe deer population, haplotype diversity was 0,800 and nucleotide diversity was 0,030. Analyses of control region mtDNA sequences indicated widespread introgression of Siberian roe deer (*C. pygargus*) mtDNA in the European roe deer genome, introgressed individuals constituted 20% of the deer studied. Samples of roe deer individuals from different regions of Lithuania were analysed by D-loop. Results of analysis revealed high level molecular genetic variation in mtDNA control region. Similar phylogenetic patterns based on mtDNA were identified in animals from Russia, Mongolia, China, Italy, France and Spain.

Keywords: mtDNA, D-loop, roe deer, genetic variability flow

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VARIJABILNOST MITOHONDRIJALNE DNK U POPULACIJI SRNDAĆA LITVANIJE

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Sažetak: Populacija srndaća u Litvaniji je veoma brojna i sastoji se od oko 115 000 jedinki. Podaci o genetičkoj varijabilnosti srndaća u Litvaniji su još uvek retki. Cilj ovog rada je bila procena genetičkog statusa srndaća u Litvaniji na osnovu analize kontrolnog regiona mtDNK. Ukupno 20 uzoraka srndaća je sakupljeno sa različitih regiona u Litvaniji. Genomska DNK je izolovana iz mišićnog tkiva korišćenjem kompleta hemikalija za ekstrakciju Genomic DNA Purification Kit. Amplifikacija kontrolnog regiona mitohondrijalnog genoma je urađena korišćenjem prajmera L-Pro i H-493. Produkti PCR amplifikacije su prečišćeni korišćenjem seta hemikalija GeneJET Gel Extraction Kit i sekvencionirani na aparatu 3130xl Genetic Analyzer. Sekvence su poravnane (engl. alignment) korišćenjem softvera BioEdit 7.2.5 i MEGA 6, a program DnaSP v.5 je korišćen za identifikaciju haplotipova. U uzorku od 20 jedinki dobijene su sekvence kontrolnog regiona mtDNK ukupne dužine od 457 bp i otkriveno je 38 varijabilnih pozicija. Izvršena je komparativne analiza sa homologim sekvencama kontrolnog regiona mtDNK koje su preuzete iz Gen Banke. Utvrđeno je ukupno 6 različitih haplotipova i postojanje dve haplogrupe u populaciji srndaća Litvanije. Od 6 pronađenih haplotipova, 3 su bila jedinstvena za populacije srndaća Litvanije, diverzitet haplotipova iznosio je 0,800, a diverzitet nukleotida 0,030. Analizom sekvenci kontrolnog regiona mtDNK utvrđeno je postojanje introgresije genoma Sibirskog srndaća (*C. pygargus*) u mitohondrijalni genom Evropskog srndaća. Kod 20% jedinki koje su analizirane je pronađena introgresija.

Urađena je analiza kontrolnog regiona mtDNK kod jedinki srndaća iz različitih regiona u Litvaniji. Rezultati ove analize su pokazali visoku genetičku varijabilnost mtDNK. Sličan filogenetički obrazac je ranije uočen u populacijama srndaća u Rusiji, Mongoliji, Kini, Italiji, Francuskoj i Španiji.

Ključne reči: mtDNK, D-petlja, srndać, genetička varijabilnost

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COMPARATIVE ANALYSIS OF WILD BOAR AND DOMESTIC PIG POPULATIONS BASED ON MICROSATELLITES DATA

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Summary: Wild boar is very important and one of the most abundant game species in hunting areas of Vojvodina. Genetic characterization of different wild boar populations can provide data useful for monitoring, identification and traceability of animals. A particular problem related to wild boar is the need to avoid or monitoring genetic introgression from domestic pigs. The main aim of this study was to estimate genetic variability of wild boar populations in Vojvodina and to compare it with domestic pig populations, using eleven tetranucleotide microsatellite markers. Total number of 63 wild boars from Vojvodina and 33 domestic pigs were collected. Multiplex PCR amplification of 11 tetranucleotide microsatellites was carried out. Genetic variability and population structure was assessed using standard population-genetic softwares. Bayesian cluster analysis implemented in STRUCTURE clearly separated wild boars from domestic pigs. In the analyzed sample of wild boars from Vojvodina, total number of 117 alleles was revealed, with a mean number of 10.6 alleles per locus, while in domestic pigs total number of alleles was 137, with a mean number of alleles per locus 12.45. The number of private alleles for wild boar populations was 40, while 61 private alleles were observed in domestic pigs. Average observed and expected heterozygosity values in wild boars were 0.69 and 0.79, while observed heterozygosity in domestic pigs was 0.67 and expected heterozygosity was 0.82. High genetic variability was observed in both wild boars and domestic pigs. Our results point out that management strategy should be narrowed to preserve observed level of genetic variability in both wild and domestic forms. Moreover, management of wild boar populations should be focused on preventing uncontrolled translocations and crossbreed with domestic pigs.

Key words: wild boar, domestic pig, microsatellite variability, Vojvodina

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KOMPARATIVNA ANALIZA POPULACIJA DIVLJE I DOMAĆE SVINJE NA OSNOVU MIKROSATELITSKIH PODATAKA

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Sažetak: Divlja svinja je veoma važna i jedna od najbrojnijih lovnih divljači u lovištima Vojvodine. Genetička karakterizacija različitih populacija divlje svinje može da rezultuje podacima korisnim za monitoring, identifikaciju i praćenje jedinki. Konkretno problem kod divljih svinja jeste potreba da se izbegne ili prati introgresija genoma domaće svinje. Cilj ovog rada je bio da se uradi procena genetičke varijabilnosti populacija divlje svinje u Vojvodini i da se uporedi sa genetičkom varijabilnosti prisutnom u populacijama domaće svinje primenom jedanaest tetranukleotidnih mikrosatelitskih lokusa. Sakupljeno je ukupno 63 uzorka divljih svinja iz Vojvodine i 33 uzorka domaće svinje. Nakon ekstrakcije DNK, urađena je multipleks PCR amplifikacija 11 mikrosatelitskih lokusa. Za procenu genetičke varijabilnosti i strukture populacije korišćeni su standardni populaciono-genetički softveri. Klaster analiza zasnovana na Bajesovoj statistici urađena je u programu STRUCTURE i pokazala da se divlje i domaće svinje jasno genetički odvajaju. U analiziranom uzorku divljih svinja iz Vojvodine pronađeno je ukupno 117 različitih alela, sa prosečnom vrednošću od 10,6 alela po lokusu, dok je kod divljih svinja ukupan broj alela iznosio 137, sa prosečnom vrednošću od 12,45 alela po lokusu. Broj jedinstvenih alela za populacije divlje svinje bio je 40, dok je broj jedinstvenih alela kod domaće svinje iznosio 61. Prosečne vrednosti uočene i očekivane heterozigotnosti kod divljih svinja iznosile su 0,69 i 0,79, dok je uočena heterozigotnost kod domaćih svinja bila 0,67, a očekivana 0,82. Visoka genetička varijabilnost uočena je i kod divljih i kod domaćih svinja. Rezultati ovog istraživanja ukazuju na činjenicu da strategije upravljanja vrstom treba usmeriti ka očuvanju uočenog visokog nivoa genetičke varijabilnosti. Pored toga, strategije upravljanja u populacijama divlje svinje treba takođe usmeriti ka sprečavanju nekontrolisanih translokacija jedinki i sprečavanju i praćenju hibridizacija sa domaćom svinjom.

Ključne reči: divlja svinja, domaća svinja, varijabilnost mikrosatelita, Vojvodina

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PHYLOGEOGRAPHIC POSITION OF BROWN HARES FROM VOJVODINA

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Summary: Previous phylogeographic analyses revealed presence of five different haplogroups in brown hares based on mtDNA variability: ‘Anatolian/Middle East type haplogroup’ (Turkey, Israel, north-eastern Greece, Bulgaria); ‘south-eastern European type haplogroup’ (Greece, Bulgaria, Croatia, Italy); ‘European type haplogroup’, divided into two subgroups: subgroup A (central Europe, the United Kingdom, Spain, France, Netherlands, Germany, Bulgaria) and subgroup B (Greece, Crete, Bulgaria); and ‘intermediate haplogroup’ (Greece, Bulgaria). The postglacial recolonization of central and northwestern continental Europe by the brown hare has started exclusively from the Balkans due to the lack of profound geographical barriers in south-north direction. The aim of this study was to determine phylogeographic position of the brown hare (*Lepus europaeus*) in Vojvodina (the Northern Province of Republic of Serbia) by analyses of control region mtDNA sequence variability. In total, 135 brown hares, sampled in a period 2004-2014, were analysed for mitochondrial DNA variation by sequence analysis of the control region (CR-I). The data were compared with mtDNA CR-I sequences retrieved from GenBank. Genetic diversity was determined using standard population-genetic softwares. Haplotype diversity was $Hd=0.915$ and nucleotide diversity $\pi=0.012$. Phylogeographic analysis revealed two main groups corresponding to ‘Anatolian/Middle East type haplogroup’ and ‘European type haplogroup’, while the second was divided into two subgroups, which corresponded to subgroups A and B. The majority of haplotypes found in brown hares from Vojvodina were grouped in ‘European type haplogroup’ subgroup A, while two were grouped in ‘Anatolian/Middle East type haplogroup’. The presence of these haplotypes is expected in the south-eastern Balkans, and not in the north Balkans. It might be that translocations could be responsible for the presence of unexpected haplotypes in this area.

Key words: brown hare, Vojvodina, mtDNA

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FILOGEOGRAFSKA POZICIJA EVROPSKOG ZECA IZ VOJVODINE

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Sažetak: Prethodne filogeografske analize pokazale su prisustvo pet haplogrupa u arealu evropskog zeca na osnovu mtDNK varijabilnosti: 'Anatolija/Bliski Istok haplogrupa' (Turska, Izrael, severno-istočna Grčka, Bugarska); 'Jugoistočna Evropa haplogrupa' (Grčka, Bugarska, Hrvatska, Italija); 'Evropska haplogrupa' podeljena u dve podgrupe: podgrupa A (centralna Evropa, Britanija, Španija, Francuska, Holandija, Nemačka, Bugarska) i podgrupa B (Grčka, Krit, Bugarska); i 'intermedijalna haplogrupa' (Grčka, Bugarska). Postglacijalna rekolonizacija evropskog zeca centralne i severozapadne Evrope bila je isključivo sa Balkana zbog odsustva značajnog geografskih barijera u pravci jug-sever. Cilj ovog rada je da se utvrdi filogeografska pozicija populacije zeca Vojvodine (Severna Autonomna Pokrajina Republike Srbije) pomoću analize varijabilnosti sekvenci kontrolnog regiona mtDNK. Ukupno je analizirano 135 jedinki izlovljenih u period 2004-2014 godina i sekvenciran je kontrolni region mtDNK (CR-I). Dobijene sekvence su upoređene sa dostupnim sekvencama preuzetim iz GenBanke. Genetički diverzitet je izračunat pomoću standardnih populaciono-genetičkih softvera. Diverzitet haplotipova bio je $Hd=0,915$ i diverzitet nukleotida $\pi=0,012$. Filogeografska analiza pokazala je prisustvo dve osnovne haplogrupe, koje odgovaraju ranije definisanim 'Anatolija/Bliski Istok haplogrupi' i 'Evropskoj haplogrupi, koja je podeljena na dve podgrupe, koje odgovaraju podgrupama A i B. Većina haplotipova koji su detektovani u populaciji zeca Vojvodine pripada podgrupi A, dok su dva haplotipa grupisana u 'Anatolija/Bliski Istok haplogrupu'. Prisustvo ovih haplotipova očekivano je u region jugoistočnog Balkana, ali ne i u region severnog Balkana. Najverovatniji uzrok prisustva ovih haplotipova jesu translokacije koje su registrovane u poslednjih pola veka na ovom području.

Ključne reči: evropski zec, Vojvodina, mtDNK

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PRELIMINARY REPORT ON GENETIC CHARACTERIZATION OF BROWN HARE IN CENTRAL-, EASTERN-EUROPE

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Summary: The present patterns of genetic variation of most breeds are strongly affected by genetic impact of the last glaciation, but many other processes with a potential effect on the genetic variation certainly occurred since then. In case of Brown hare (*Lepus europaeus*) human activities, fragmentation and isolation of the distribution areas, competition for food, breeding sites etc. among populations/breeds and the hybridization between species are these factors. Brown hare is widely distributed all over Europe. The Carpathian basin is known as a hotspot for biodiversity in most of European species. The main aim of this study is to investigate genetic diversity of Brown hare in Central and Eastern Europe, to reveal the genetic history of the present Brown hare population in the Carpathian basin and to elucidate phylogeographic patterns using published mtDNA sequence data originating from different parts of Europe. Till now, the total of 35 animals were sampled in different parts of Hungary, Poland and Romania. A 1062-bp sequence of mitochondrial cytochrome b (*Cyt-b*) was analyzed. It showed a high level of divergence (haplotype diversity 0.967, nucleotide diversity 1.14%). Phylogeographic analysis on *Cyt-b* of mitochondrial DNA revealed geographical and genetical distinction among the studied populations. This preliminary work tend to show high genetic diversity for the Brown hare in the studied region, however it needs to be confirmed by further study as well.

This research was supported by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP-4.2.4.A/ 2-11/1-2012-0001 ‘National Excellence Program.

Key words: hare, mitochondrialDNA, diversity, Central-, Eastern Europe

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PRELIMINARNI IZVEŠTAJ O GENETSKOJ KARAKTERIZACIJI ZECA U CENTRALNOJ I ISTOČNOJ EVROPI

Kusza Sz¹ Szendrei L.¹

Sažetak: Postojeći modeli genetičke varijabilnosti većine populacija u uzgoju su pod uticajem kako promena genetičke varijabilnosti u toku poslednje glacijacije, tako i mnogih drugih procesa koji imaju uticaja na genetičku strukturu. U slučaju evropskog zeca (*Lepus europaeus*) aktivnosti čoveka, fragmentacija i izolacija staništa, kompeticija u ishrani, parenju itd. između populacija kao i interspecijska hibridizacija predstavljaju ove faktore. Evropski zec je široko rasprostranjen u Evropi. Karpatski basen je poznat kao centar biodiverziteta za većinu evropskih vrsta. Cilj ovog rada je da se ispita genetički diverzitet populacija evropskog zeca u centralnoj i istočnoj Evropi, i da se otkrije genetička istorija populacija u Karpatskom basenu, kao i da se definišu filogenetički odnosi pomoću sekvenci mtDNK evropskog zeca širom Evrope. Do sada, 35 jedinki je uzorkovano u različitim regionima Mađarske, Poljske i Rumunije. Sekvenca od 1062bp mitohondrijalnog citohrom b (Cyt-b) gena je analizirana. Pokazan je visok nivo genetičke divergencije (diverzitet haplotipova 0.967; diverzitet nukleotida 1.14%). Filogeografska analiza na osnovu Cyt-b mitohondrijalne DNK pokazala je prisustvo geografske i genetičke udaljenosti između analiziranih populacija. Ovi preliminarni rezultati ukazuju na visok genetički diverzitet evropskog zeca u analiziranom regionu, što je neophodno potvrditi širim analizama.

Ovo istraživanje je finansijski podržano od strane Evropske Unije i Mađarske, i ko-finansirano od strane European Social Fund TÁMOP-4.2.4.A/ 2-11/1-2012-0001 'National Excellence Program.

Ključne reči: evropski zec, mitohondrijalna DNK, diverzitet, Centralna i Istočna Evropa

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**GENETIC STRUCTURE OF CHAMOIS FROM NORTHWESTERN
DINARIDES, A PART OF BALKAN PENINSULA**

Šprem N.¹, Cubric-Curik V.², Buzan V.E.^{3,4}

Summary: Croatia provides a unique opportunity to address questions regarding the effects of past hunting management on genetic structure and possible hybridization in the contact zone. In this study we used microsatellite and mitochondrial markers to analyse genetic variation and structure of chamois populations from different geographical areas with profoundly different histories. Specifically, we explored the areas in assumed contact zone, influence of the recent human translocations to the population structure and how geographical isolation is reflected in the genetic architecture of chamois populations. We successfully genotyped 74 individual samples, the number of alleles per locus (A) ranged from 6 to 20 with a mean of 9.20. The AR across populations ranged from 2.94 to 3.56 being the highest in the Prenj Mts. and lowest in the Biokovo Mts. Similar pattern was observed also for H_o , ranging between 0.729 and 0.572, and H_e , between 0.762 and 0.644. The global F_{ST} for seven population samples was 0.103 ± 0.047 (range 0.01584 – 0.18471). The STRUCTURE result clearly separated samples from the Northern Dinaric Mts. (*R.r. rupicapra*) in tree clusters and from southern Dinaric Mts. (*R.r. balcanica*) in two clusters according to geographic location, the similar result we obtained even with BAPS. By utilising mtDNA variation in chamois from Slovenia, Croatia and Bosnia and Herzegovina, we confirm existence of *rupicapra* haplotypes on sites (GOT, CVE and GKO) and *balcanica* haplotypes on sites (PRE, NVE, CVE, BIO and DIN). Therefore, our data interfered the phylogenetic status of chamois from north western Dinaric Mts.

Key words: *R.r. rupicapra*, *R.r. balcanica*, Dinaric mountains, microsatellites, mtDNA

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**GENETSKA STRUKTURA DIVOKOZA SJEVERNO-ZAPADNIH DINARIDA,
KAO DIO BALKANSKOG POLUOTOKA**

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Sažetak: Hrvatska pruža jedinstvenu priliku za rešavanje pitanja učinka lovnog gazdovanja u prošlosti, o genetskoj strukturi i mogućoj hibridizaciji u kontaktnoj zoni. U ovom istraživanju koristili smo microsatelite i mitohondrijske markere za analizu genetske varijacije i strukture populacije divokoza iz različitih područja koje imaju različitu istoriju. Naime, istraživali smo područja u pretpostavljenoj kontaktnoj zoni, utjecaj nedavnih ljudskih translokacija u strukturi populacije i kako se geografske izolacije ogledaju u genetskoj strukturi populacije divokoza. Uspešno je genotipizirano 74 uzoraka, broj alela po lokusu (A) u rasponu je od 6 do 20 sa prosekom od 9.20. AR unutar populacije u rasponu je od 2,94 do 3,56, najviše u Prenj a najniža na Biokovu. Slično je uočeno i za H_o , u rasponu između 0.729 i 0.572 i H_e , između 0,762 i 0,644. Globalni F_{ST} unutar sedam populacija je 0.103 ± 0.047 (raspon, 0.1584-0.18471). Rezultat STRUCTURE jasno odvaja uzorake iz severnih Dinarida. (*R.r. Rupicapra*) u tri klastera i iz južnih Dinarida. (*R.r. balcanica*) u dve grupe prema geografskom položaju, sličan rezultat dobili smo i upotrebom BAPS-a. Korišćenjem mtDNA varijabilnosti divokoza iz Slovenije, Hrvatske te Bosne i Hercegovine, potvrđuje postojanje *rupicapra* haplotipova na lokacijama (GOT, CVE i GKO) i *balcanica* haplotipova na lokacijama (PRE, NVE, CVE, BIO i DIN). Dakle, naši podaci pokazuju filogenetski status divokoza severozapadnih Dinarida.

Ključne reči: *R.r. rupicapra*, *R.r. balcanica*, Dinaridi, microsateliti, mtDNA

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DRAFTING THE BIOSECURITY MEASURES IN PHEASANTS RAISING TECHNOLOGY

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Summary: One of the key factors for successful farm production of pheasants game is to maintain constant biosecurity measures through all the phases of production technological procedure. Key biosecurity measures that should be constantly maintained in farm facilities are disinfection and pest control. The paper describes disinfection and pest control procedures and the effects thereof that served as a basis for drafting the biosecurity protocol. Besides these measures biosecurity protocol was based observing also the construction and technical characteristics of pheasant farm, i.e. farm production units and farmyard, and an applied production technological process. The mentioned research in a previous period was conducted on pheasant farm “Rit“ in Padinska Skela, near Belgrade.

Key words: pheasant farm, biosecurity measures, biosecurity protocol, disinfection, pest control

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ZNAČENJE SASTAVA STANIŠNIH TIPOVA ZA LOVNO GAZDOVANJE U HRVATSKOJ

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Sažetak: Jedan od ključnih faktora uspešne farmske proizvodnje fazanske divljači je kontinuirano sprovođenje biosigurnosnih mera kroz sve faze tehnološkog postupka proizvodnje. Ključne biosigurnosne mere koje je u farmskim objektima neophodno kontinuirano sprovoditi su dezinfekcija i deratizacija. U radu je prikazan postupak sprovođenja dezinfekcije i deratizacije, kao i njihovi efekti, koji su poslužili kao osnova za izradu biosigurnosnog protokola. Pored navedenih mera osnov za izradu biosigurnosnog protokola bile su građevinsko-tehničke karakteristike fazanerije, tj. njenih proizvodnih celina i ekonomskog dvorišta, kao i tehnološki proces proizvodnje koji se primenjuje. Navedena istraživanja u prethodnom periodu su rađena na fazaneriji „Rit“ u Padinskoj Skeli, u okolini Beograda.

Ključne reči: fazanerija, biosigurnosne mere, biosigurnosni protokol, dezinfekcija, deratizacija

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TRICHINELLOSIS IN THE WILD CARNIVORES OF REPUBLIC OF SERBIA

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Summary: We have investigated the presence of *Trichinella* infection in wild carnivores at several districts of the Republic of Serbia. The samples were collected in the cooperation with local hunting organizations and included 1326 animals such as golden jackals (*Canis aureus*), red foxes (*Vulpes vulpes*), martens (*Martes foina* and *Martes martes*), wolves (*Canis lupus*), wild cats (*Felis silvestris*), polecats (*Mustela putorius* and *Mustela eversmanni*), eurasian badgers (*Meles meles*), coypus (*Myocastor coypus*), european otters (*Lutra lutra*), northern white-breasted hedgehog (*Erinaceus roumanicus*) and domestic dogs (*Canis familiaris*). The tongue base of each animal was examined by the artificial digestion method. Among the administrative districts in Serbia, without the regions with small number of samples, the greatest percent of *trichinella* positive animals was detected at Pirot District (47,83%), followed by the Raška (20,69%), Zlatibor (20,66%), Bor (18,52%), Braničevo (17,74%), Pomoravlje (15,22%) and Podunavlje District (12,46%). According to the territorial distribution of *Trichinella* infection for the single species, with the exception of districts with small number of samples, the highest number of infected wolves was detected at the Raška District (66,67 %), martens at Braničevo (50,0 %), golden jackals at Bor (25,45 %) and red foxes at Šumadija District (16,7 %).

Key words: *Trichinellosis*, wild carnivores, Serbia

The study was supported by grants (projects TR 31034 and TR 31009) from the Ministry of Education, Science and Technological Development of Serbia.

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TRIHINELOZA KOD DIVLJIH MESOJEDA U REPUBLICI SRBIJI

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Sažetak: U radu je ispitivano prisustvo trihineloze kod divljih mesojeda u nekoliko okruga Republike Srbije. Uzorci su sakupljeni u saradnji sa lokalnim lovačkim društvima uključujući 1326 životinja i to šakale (*Canis aureus*), lisice (*Vulpes vulpes*), kune (*Martes foina* i *Martes martes*), vukove (*Canis lupus*) divlje mačke (*Felis silvestris*) tvorove (*Mustela putorius* i *Mustela eversmanni*), jazavce (*Meles meles*), nutrije (*Myocastor coypus*), vidre (*Lutra lutra*), ježa (*Erinaceus concolor*) i domaćeg psa (*Canis familiaris*). Od svake životinje ispitana je muskulatura baze jezika metodom veštačke digestije. Među administrativnim okruzima Republike Srbije, sa izuzetkom okruga u kojima je sakupljen mali broj uzoraka, najveći procenat trihineloznih životinja je pronađen u pirotskom okrugu (47,83%), a zatim raškom (20,69%), zlatiborskom (20,66%), borskom (18,52%), braničevskom (17,74%), pomoravskom (15,22%) i podunavskom okrugu (12,46%). Što se tiče teritorijalne rasprostranjenosti trihineloze kod pojedinih vrsta životinja, najveći broj *Trichinella*-pozitivnih vukova utvrđen je u raškom okrugu (66,67 %), kod kuna u braničevskom okrugu (50,0 %), kod šakala u borskom okrugu (25,45 %) i kod lisica u šumadijskom okrugu (16,7 %).

Ključne reči: trihinelozna, divlji mesojedi, Srbija

Rezultati su proistekli iz istraživanja u okviru projekata TR 31034 i TR 31009 koje finansira Ministarstvo prosvete, nauke i tehnološkog razvoja republike Srbije.

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FINDINGS OF TICKS IN CARE OF SOME SPECIES OF WILD CARNIVORES

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Summary: In the natural habitat of Vojvodina there are different species of carnivores. Inside of this order in our hunting grounds the most often present are foxes (*Vulpes vulpes*) and jackal (*Canis aureus*). They are able to live at different habitat and they are part of animals fauna which can have useful and harmful influence on nature. One of the negative impact is reflected as possibility to carry or transfer, over vector, different contagious disease which can be dangerous for wild and domestic animals as well as for human. From hematophagic parasites that jeopardize population of wild animals, ticks have a special place because they can, in addition to the direct impact on the health of parasitism, to be vectors of various infectious diseases. Monitoring the presence of this type of ectoparasites allows to detect the presence of ticks and collect data on possible infectious diseases. In regarding of mentioned reasons the object of our study is to collect ticks in foxes and jackal with goal to determine in whom the hunting ground is there animals that carries this type of parasites and which species of ticks we can found in this population of wildlife. Ticks are collected from animals which hunted and which are brought in laboratory for examination. There have been 23 hunted foxes and 20 of jackals. Animals are taken from two hunting ground from Srem and one from Bačka. We determined presence of 4 species of ticks: *Dermacentor marginatus*, *Haemaphysalis punctata*, *Ixodes ricinus* and *Rhipicephalus sanguineus*.

Keywords: foxes, jackal, ticks, health

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NALAZ KRPELJA KOD NEKIH VRSTA DIVLJIH KARNIVORA

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Sažetak: U prirodnim staništima Vojvodine nalaze se različite vrste karnivora. U okvir ovoga reda najčešće se u našim lovištima mogu sresti lisica (*Vulpes vulpes*) i šakal (*Canis aureus*). Mogu živeti na različitim staništima i spadaju u životinje koje imaju korisni i štetni uticaj na prirodu. Jedan od negativnih uticaja ogleda se na mogućnost da nose ili da prenose, preko vektora, različite zarazne bolesti koje mogu biti opasne kako za divlje i domaće životinje tako i za ljude. Od hematofagih parazita koji ugrožavaju populaciju divljači, krpelji imaju posebnu ulogu jer mogu, pored direktnog uticaja na zdravlje parazitizmom, da predstavljaju vektore različitih zaraznih bolesti. Praćenje prisustva ove vrste ektoparazita omogućuje da se sagleda zastupljenost krpelja i sakupe podaci o eventualnim infektivnim bolestima. Iz navedenih razloga predmet našeg rada je sakupljanje krpelja kod lisica i šakala sa ciljem da se utvrdi u kojim lovištima se nalaze životinje koje su nosioci ovog parazita i koje se vrste krpelja nalaze u ovoj populaciji divljači. Krpelji su sakupljani sa životinja koje su odstreljene i koje su donošene u laboratoriju na ispitivanje. Pregeledano je 23 odstreljenje lisice i 20 šakala. Životinje su donošene iz dva lovišta u Sremu i jednog iz Bačke. Utvrđeno prisustvo 4 vrste krpelja: *Dermacentor marginatus*, *Haemaphysalis punctata*, *Ixodes ricinus* i *Rhipicephalus sanguineus*.

Ključne reči: lisica, šakal, krpelji zdravlje

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PRESENCE OF LYME DISEASE IN TICKS FROM WILD LIFE

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Summary: Ticks are obligate blood feeders that live on a wide range of animals, including wild animals. Several hundreds of different tick species are known in the world and they can be vectors for different infectious agents. In the region of Vojvodina Province (northern part of Serbia) the following tick species can be found: *Ixodes ricinus*, *Haemaphysalis punctata*, *Haemaphysalis concinna*, *Rhipicephalus sanguineus*, *Dermacentor marginatus* and *Dermacentor reticulatus*. *Ixodes ricinus* is a well known vector of *Borrelia burgdorferi*.

A study was done during 2012-2013, which involved collection and analysis of ticks from hunted animals. In total 216 ticks were collected from hunted animals, mainly from roe deer, but ticks found on some jackals and foxes were also collected.

From the total number of collected ticks during this two years period, 73,6% were of *I. ricinus* species. Considering the year of study 58% of collected ticks were of *Ixodes ricinus* species during 2012 and 89% during 2013. The rest of the collected ticks (26,4%) belongs to *Dermacentor*, *Rhipicephalus* and *Haemaphysalis* species.

Ixodes ricinus ticks were analysed by microscopic examination of their abdominal content in dark field in order to confirm the presence of spirochetes. During 2012, 10 ticks were found to be positive for the presence of *B. burgdorferi* (15,6%) and during 2013, the percentage of detected positive ticks was 7,4%. In total for the period of study, the percentage of ticks from wild animals that was found positive for the presence of causative agent of Lyme disease was 10,69%.

The results obtained in our study are in accordance to the data described in available literature on prevalence of borreliosis in ticks in the region of Vojvodina, that ranges from 0-28%, indicating the continuous presence of the causative agent of borreliosis in ticks in the region and the hazard for animal and human health.

Key words: wildlife, ticks, Lyme borreliosis

This study was supported by grant TR31084 from Serbian Ministry of Education, Science and Technological Development

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PRISUSTVO UZROČNIKA LAJMSKE BOLESTI U KRPELJIMA SA DIVLJAČI

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Sažetak: Krpelji se kao organizmi koji se hrane krvlju se mogu naći na veoma širokoj paleti životinja, uključujući i divlje životinje. Danas je u svetu poznato više stotina različitih vrsta krpelja, koji mogu biti vektori različitih infektivnih agenasa. U regionu pokrajine Vojvodine (severni deo Srbije) su do sada detektovane sledeće vrste krpelja: *Ixodes ricinus*, *Haemaphysalis punctata*, *Haemaphysalis concinna*, *Rhipicephalus sanguineus*, *Dermacentor marginatus* i *Dermacentor reticulatus*. *Ixodes ricinus* je poznati vector za *Borrelia burgdorferi*.

Vršeno je istraživanje tokom 2012-2013 godine tokom kojeg su sakupljeni i pregledani krpelji koji su skinuti sa ulovljene divljači. Ukupno je sakupljeno 216 krpelja sa divljači i to uglavnom sa srndaća, dok je nekoliko krpelja skinuto i sa šakala i lisica.

Tokom dvogodišnjeg istraživanja, od ukupnog broja sakupljenih krpelja, 73,6% su pripadali *I. ricinus* vrsti. Ako posmatramo po godinama, tokom 2012 godine je procenat krpelja koji su pripadali *I. ricinus* vrsti bio 58% od ukupno sakupljenih krpelja, a tokom 2013 ova vrednost je bila 89%. Ostali deo sakupljenih krpelja (26,4%) je pripadao *Dermacentor*, *Rhipicephalus* i *Haemaphysalis* vrstama.

Ixodes ricinus krpelji su pregledani metodom mikroskopije u tamnom polju, radi otkrivanja prisustva spiroheta u sadržaju abdomena. Tokom 2012. godine, 10 krpelja su bili pozitivni na prisustvo *B. burgdorferi* (15,6%) , a tokom 2013., procenat detektovanih pozitivnih krpelja je iznosio 7,4%. Tokom ukupnog perioda istraživanja, broj krpelja skinutih sa divljači koji su bili pozitivni na prisustvo uzročnika lajmske bolesti, iznosio je 10,69%.

Dobijeni rezultati o prevalencije borelioze u krpeljima, za region Vojvodine, su u saglasnosti sa podacima koji mogu da se nađu u dostupnoj literaturi, gde se navodi podatak od 0-28%. Ovaj podatak ukazuje na kontinuirano prisustvo uzročnika borelioze u krpeljima, kao i rizik za zdravlje životinja i ljudi.

Ključne reči: divljač, krpelji, Lajm borelioz.

Istraživanje je realizovano po projektu TR31084 koji se finansira od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

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ANTIBODIES TO SELECTED VIRAL DISEASE AGENTS IN HUNTED WILD BOARS IN VOJVODINA REGION

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Summary: Worldwide, the population density of the wild boar seems to be increasing, which not only means a larger number of hosts available for the transmission of disease, but also a higher contact rate between hosts. Knowledge of diseases circulating in wildlife populations can be important not only for conservation and livestock production but also for public health. The aim of the current study was to investigate the presence of antibodies to selected viral disease agents (PRRSV, PPV and CSFV) in hunted wild boars of Vojvodina region. Blood samples from 300 hunted wild boars from hunting ground of Vojvodina were collected during the hunting season from October 2011 until March 2012. Presence of anti-PRRSV and anti-CSFV antibodies was determined using a commercially available ELISA test kits while the presence of anti-PPV antibodies was determined using the method of haemagglutination inhibition (HI test). Out of total 300 examined blood samples, in 49.33% antibodies against PPV, 1.33% antibodies against PRRSV and 10.33% antibodies against CSFV was detected. These results, support the hypothesis that wild boar are reservoirs of certain viral infectious agents, but some infections in wild boars originate from domestic swine. 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.

Key words: wild boars, swine viral diseases, Vojvodina

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**UTVRĐIVANJE PRISUSTVA ANTITELA PROTIV ODREĐENIH
VIRUSNIH BOLESTI KOD IZLOVLJENIH DIVLJIH SVINJA
U REGIONU VOJVODINE**

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Sažetak: Smatra se da se u svetu gustina populacije divljih svinja uvećava, što ujedno ne znači samo veći broj organizma- domaćina za prenošenje uzročnika bolesti, već isto tako i veći stepen kontakta među domaćinima. Poznavanje uzročnika bolesti koje cirkulišu u populaciji divljih životinja je značajno ne samo za njeno očuvanje i stočarsku proizvodnju već isto tako i za očuvanje javnog zdravlja. Cilj ispitivanja je bio utvrđivanje prisustva antitela protiv određenih virusnih bolesti svinja (PRRSV, PPV i virusa KKS) kod izlovljenih divljih svinja u regionu Vojvodine. Uzorci krvi od ukupno 300 izlovljenih divljih svinja u lovištima regiona Vojvodine su prikupljeni tokom lovne sezone od oktobra 2011. do marta 2012. godine. Serološka ispitivanja na prisustvo antitela protiv virusa PRRS i KKS virusa su vršena odgovarajućim imunoenzimskim (ELISA) testovima, dok je ispitivanje na prisustvo antitela protiv PPV vršeno testom hemaglutinacija inhibicije (HI test). Od ukupno 300 ispitanih uzoraka krvi, u 49.33% je utvrđeno prisustvo antitela protiv PPV, u 1.33% antitela protiv virusa PRRS i u 10.33% ispitanih uzorka je utvrđeno prisustvo antitela protiv virusa KKS. Postignuti rezultati ispitivanja, podržavaju hipotezu da divlje svinje predstavljaju rezervoar određenih uzročnika virusnih bolesti, ali i da određene infekcije divljih svinja vode poreklo iz populacije domaćih svinja. Imajući u vidu navedeno, od posebnog značaja je aktivni nadzor divljih svinja u područjima gde je moguć njihov bliski kontakt sa populacijom domaćih svinja.

Ključne reči: divlje svinje, virusne bolesti svinja, Vojvodina

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THE PRESENCE OF PESTICIDES AND TOXIC ELEMENTS IN MEAT AND INTERNAL ORGANS OF GAME (REGION OF VOJVODINA)

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Summary: Total of seven different wild bird species: Pheasant (*Phasianus calchicus*), Woodcock (*Scolopax rusticola*), Wild duck (*Anas platyrhynchos*), Buzzard (*Buteo buteo*), White-tailed eagle (*Haliaeetus albicilla*), Crane (*Grus grus*), Long-eared Owl (*Asio otus*) were examined. Lead, cadmium, arsenic and mercury were analyzed by the method of coupled plasma-mass spectrometry and the qualitative and quantitative analysis for the presence of pesticides was performed applying the gas chromatography–mass spectrometry method. Samples of meat, liver, heart and spleen have been analyzed for the presence of DDT derivatives, lindan and the sum of heptachlor and heptachlor epoxide. Significant amount of these compounds has been detected mostly in samples of internal organs. The presence of cadmium has been detected in a pheasant liver (0.092 - 0.155 mg/kg), in the meat of a wild duck (0.751 mg/kg) while significant level of Pb was found in a liver of a crane (0.129 - 0.170 mg/kg) and in the meat of a wild duck (0.117 mg/kg) and pheasant spleen (0.400 mg/kg).

Key words: Pesticides, Toxic Elements, Meat, Liver, Heart, Spleen

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**SADRŽAJ PESTICIDA I TOKSIČNIH ELEMENATA U MESU I
UNUTRAŠNJIM ORGANIMA DIVLJAČI (PODRUČJE VOJVODINE)**

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Sažetak: Ukupno je ispitano sedam različitih vrsta divljih ptica: fazan (*Phasianus calchicus*), šljuka (*Scolopax rusticola*), patka (*Anas platyrhynchos*), mišar (*Buteo buteo*), orao belorepan (*Haliaeetus albicilla*), ždral (*Grus grus*) i sova (*Asio otus*). Olovo, kadmijum, arsen i živa analizirani su metodom spregnute plazme sa masenom detekcijom a kvaliatativno i kvantitativno utvrđivanje prisustva pesticida izvršeno je primenom gasno-masene hromatografije. Analizirani su uzorci mesa, jetre, srca i slezine. Od ostataka pesticida utvrđeno je prisustvo DDT derivata, lindana i sume heptahlor i heptahlor epoksida, posebno u analiziranim unutrašnjim organima. Od toksičnih elemenata utvrđeno je značajnije nakupljanje Cd u jetri fazana (0.092-0.155 mg/kg) i mesu divlje patke (0.751 mg/kg) dok je značajniji nivo Pb izmeren u jetri ždralova (0.129-0.170 mg/kg), mesu divlje patke (0.117 mg/kg) i slezini fazana (0.400 mg/kg).

Gljučne reči: pesticidi, toksični elementi, meso, jetra, srce, slezina

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RETROSPECTIVE STUDY ON THE CAUSE OF DEATH IN PROTECTED AND STRICTLY PROTECTED WILD ANIMALS IN VOJVODINA FROM YEAR 2011 TO 2014

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Summary: The Autonomous Province of Vojvodina, one of the largest and rare biodiversity areas, that encompasses 21506 km², is faced with endangering and distinction of alarming number of plant and animal species. The Scientific Veterinary Institute “Novi Sad” has initially participated in a one year pilot project, financially supported by the Secretariat for Science and Technological Development of Vojvodina. Afterwards, the project activities have been prolonged until year 2014, and included monitoring and determination of the cause of disease in protected and strictly protected wild animals. In the study, the mortality matrix and the observed seasonal changes in the populations of wild animal, were summarised and presented. Total of 324 carcasses were submitted to the Institute, including 14 species of wild birds and 4 of mammals. Complete postmortem examinations and accordingly selected laboratory assays were conducted. The obtained results indicate that major factors that are responsible for the death and losses in wild animals include global climate changes, human factor and increase of road traffic density. In addition, certain seasonality in the matrix of death was established. A continuous monitoring of wild animals is necessary in order to protect biodiversity.

Key words: protected wild animals, cause of disease, Vojvodina Province

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**RETROSPEKTIVA UZROKA UGINUĆA ZAŠTIĆENIH I STROGO
ZAŠTIĆENIH DIVLJIH ŽIVOTINJA U VOJVODINI ZA PERIOD
2011 – 2014. GODINE**

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Sažetak: Teritorija Autonomne Pokrajne Vojvodine je jedan od najvećih Evropskih centara biodiverziteta, površine 21.506 km², ali i područje ugroženosti, nestajanja i nestanka alarmantno velikog broja vrsta životinja i ptica. U Naučnom institutu za veterinarstvo “Novi Sad” izvršena je obdukcija, patomorfološki pregled i potrebna laboratorijska ispitivanja ukupno 324 dostavljenih leševa divljih životinja svrstanih u 14 vrsta ptica i 4 vrste sisara.

Osnovni zadatak istraživanja je bio nastavak jednogodišnjeg pokrajinskog pilot projekta „Utvrdjivanje uzroka uginuća zaštićenih i strogo zaštićenih divljih vrsta životinja AP Vojvodine u 2011. godini“, koja su izvršena tokom 2012; 2013 i 2014. godine zaključno sa majom mesecom. Cilj rada je bio retrospektivno sagledavanje: broja, dominantnosti uzroka uginuća i izvesna sezonalnost u matrici uginuća zaštićenih divljih životinja.

Rezultati nalaza patomorfoloških promena i usmerenih laboratorijskih ispitivanja kod uginulih zaštićenih divljih životinja ukazuju na dominantan značaj sledećih uzroka: globalnih klimatskih promena, antropoloških faktora i povećanje drumske saobraćajne mreže. Pored toga, uočena je izvesna sezonalnost u matrici uginuća. Neophodan je kontinuirani monitoring zaštićenih divljih životinja u cilju očuvanja biodiverziteta.

Ključne reči: zaštićene divlje životinje, uzrok uginuća, područje Vojvodine

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MORPHOMETRIC CHARACTERIZATION OF BULGARIAN BARAK

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Summary: The Bulgarian barak is unstandardized and internationally unrecognized Bulgarian autochthonous breed of scent hounds. Austrian researcher Franz B. Laszka conducted first zootechnical research on scent hounds originating from the Balkans and divided these hounds into three groups based on hair type: short-haired, long-haired and wire-haired. The Bulgarian barak is the only long-haired scent hound breed known on the Balkans at this time.

The goal of our research was morphometric characterization, assessment and analysis of twelve exterior parameters in dogs of this breed found in the areas of Sofia, Železnica, Haskovo, Pazarčik and Kirgal.. Measurements were taken with Lyditi measuring stick, zootechnics measuring tape and slide ruler with nonius. A total of 64 dogs were measured, of which there were 36 males and 28 bitches. Statistical significance of difference between observed parameters in males and bitches was calculated using the T-test.

It was determined that the mean height at withers of males was 55.33 cm, and in bitches 51.28. Mean body length of males was 63.74 cm, and in bitches 63.09 cm. No statistical difference between sexes was found for this trait ($p>0,05$). Mean head length of males was 24.55 cm, with range from 22.00 to 27.00 cm. Mean head length in bitches was 22.75 cm with range from 19.00 to 25.00 cm.

These results show that there are distinct differences between the Bulgarian barak and other, already studied, scent hound breeds from the Balkan peninsula. According to the exterior characteristics the Bulgarian barak is most similar to Bulgarian scent hound.

Key words: barak, morphometrics, scent hound, long-haired

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MORFOMETRIČE KARAKTERISTIKE BUGARSKOG BARAKA

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Sažetak: Bugarski barak je ne standardizovana i međunarodno nepriznata bugarska autohtona rasa goniča. Austrijski istraživač Frantz B. Laszka, j sproveo prvo istraživanje pasa tragača poreklom sa Balkana, i podelivši pse u tri grupe, na osnovu tipa dlake: kratkodlaki, dugodlaki i oštrodlaki. Bugarski barak je jedini dugodlaki gonič poreklom sa Balkana u ovom trenutku. Cilj našeg istraživanja je bila morfometrijska karakterizacija, procena i analiza dvanaest eksterijernih parametara pasa ove rase koji se nalaze u oblasti Sofija, Železnica, Haskovo, Pazarčik i Kirgal. Merewa su izvršena litinovima štapićima, mernom pantljkicom, i kliznim lenjirom sa nonijusom (šubler). Ukupno na 64 psa su izvršena merenja, od kojih je bilo 36 mužjaka i 28 ženki. Statistička značajnost između posmatranih parametara u mužjaka i ženki je analizirana t-testom. Utvrđeno je da je srednja visina grebena mužjaka bila 55,33 cm, a kod ženki 51,28 cm. Prosečna dužina u mužjaka je bila 63,74 cm, a u ženki 63,09 cm. Nije bilo statistički značajnih razlika ($p>0,05$) za prethodno pomenute vrednosti. Prosečna dužina glave mužjaka je bila 24,55 cm, sa opsegom od 22,00 do 27,00. Prosečna dužina glave u kuja je bila 22,75 cm, sa opsegom od 19,00 do 25,00. Ovi rezultati ukazuju da postoje jasne razlike između Bugarskog baraka i drugih, već proučenih, goniča poreklom sa Balkanskog poluostrva. Prema karakteristikama eksterijera bugarski Barak je najbliži Bugarskim goničima

Ključne reči: barak, morfometrija, gonič, dugodlaki

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HUNTERS' PERCEPTION OF DIFFERENCES BETWEEN THEMSELVES AND OTHER INTEREST GROUPS AND THE CONSEQUENCES ON WILDLIFE MANAGEMENT

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Summary: Wildlife management is a complex task which needs the cooperation of many different interest groups, including agriculture, forestry, tourism, nature conservation and hunting. Although all of these groups share a high appreciation of nature, there are often conflicts about how to manage its wildlife and ecosystems. For wildlife managers it is essential to understand the drivers of such conflicts in order to overcome impasses in wildlife and ecosystem management.

The starting point of this paper was the assumption that there is often more to these conflicts than just material interests. As hunters play a major role in wildlife and ecosystem management our aim was to identify drivers of conflicts from their perspective. We analysed passages of group discussions with hunters in different regions of southwest Germany (originally carried out on the topic of the lynx) in which hunters reflect on such conflicts. The method for analyses was Bohnsack's documentary method.

The results show, that hunters find themselves in a dilemma of differing societal expectations when it comes to wildlife management, none of which reflect their own values and moral standards. Furthermore hunters feel that their work is under-appreciated and that the knowledge and competencies on which they pride themselves are often disrespected. This creates the wish to positively distinguish from the groups they interact with. However, group differentiation, according to the theory of social identity, leads to group conflict. This conflict can extend from the images the groups have of each other and reflect onto the topics where they interact, such as wildlife management, and may even result in poaching. The aim of our article is to draw attention to such group differentiation processes and its effects, to help wildlife managers further communication and cooperation between the interacting groups.

Key words: social conflict, group conflict, hunters, nature conservation, interaction

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**PERCEPCIJA LOVACA NA RAZLIKE IZMEĐU NJIH I DRUGIH
INTERESNIH GRUPA I POSLEDICE NA GAZDOVANJE DIVLJAČI**

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Sažetak: Gazdovanje divljači je složen zadatak koji zahteva saradnju različitih interesnih grupa, uključujući poljoprivredu, šumarstvo, turizam, zaštitu prirode i lovstvo. Iako sve ove grupe poštuju prirodu, često dolazi do sukoba zbog načina na koji treba gazdovati sa divljači i ekosistemima. Za stručnjake koje se bave gazdovanjem divljači je veoma važno da razumeju uzroke sukoba da ih prevaziđu u gazdovanju divljači i ekosistema.

Početna pretpostavka u ovom radu je da ovi sukobi prevazilaze materijalne interese. Pošto lovci imaju važnu ulogu u gazdovanju divljači i ekosistemima, naš cilj je bio da identifikujemo uzroke sukoba sa njihovog gledišta. Analizirali smo delove grupnih diskusija lovaca u različitim delovima jugozapadne Nemačke (koje su bile na temu gazdovanja risom) u kojima su lovci iskazali svoje vidjenje problema. Korišćeni metod za analizu je Bonsakov dokumentarni metod.

Rezultati ukazuju da se lovci nalaze u dilemi zbog drugačijih društvenih očekivanja oko gazdovanja divljači, koji se ne poklapaju sa njihovim vrednostima i moralnim standardima. Takođe lovci smatraju da se njihov rad podcenjuje, kao i da se njihovo znanje i stručnost na koje su ponosni ne poštuje. Ovo kod njih podstiče želju za izdvajanjem od drugih grupa sa kojima imaju interakciju. Izdvajanje grupe, prema teoriji društvenog identiteta, vodi sukobu sa drugim grupama. Ovaj sukob se od međusobnog mišljenja među grupama može preneti na oblast njihove interakcije, kao što je gazdovanje divljači, ili čak rezultovati lovokradom. Cilj ovog rada je da ukaže na takve procese izdvajanja grupa i njihove efekte, kao i da pomogne stručnjacima koji gazduju divljači u komunikaciji i saradnji sa grupama sa kojima imaju interakciju.

Ključne reči: društveni sukob, sukob grupa, lovci, zaštita prirode, interakcija

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THE PROSPECTS OF HUNTING TOURISM IN THE CONCEPT OF INTEGRAL DEVELOPMENT OF THE RURAL ECONOMY

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Summary: With 43% of the population lives in rural areas and that cover about 80% of the territory, rural development is vital to the overall economic development of the country. This space is for a number of decades, under the influence of the various problems that have led to delays in its development, of loss of human resource up to low management of a variety of natural and of cultural capacities which directly implies its devastation. It should be noted that the rural space Serbia represents an area of potential development, ie a great part thereof is unused and in addition it has the potential opportunities in terms of of developing different activities, especially non-agricultural. This also applies to the development of tourism as an activity that can have a significant impact on the economic, demographic, social and functional structure of rural areas. One of his potentially promising aspects, represents hunting tourism. Hunting tourism is a specific form of tourism that is being developed by the desire of hunters to hunt and out of their hunting grounds, hunting units, or even outside of the country, for what they are paying a fee. It is characterized by exclusivity, contributes to the extension of of the tourist season, is realized in rural areas and contribute to the growth of the total income of all stakeholders in its implementation.

Key words: development, hunting tourism, rural economics, integral

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PERSPEKTIVE LOVNOG TURIZMA U KONCEPTU INTEGRALNOG RAZVOJA RURALNE EKONOMIJE

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Sažetak: Sa 43% stanovništva koje živi u ruralnim područjima i koja obuhvataju oko 80% teritorije, ruralni razvoj je od vitalnog značaja za ukupan privredni razvoj zemlje. Ovaj prostor je već duži niz decenija pod uticajem različitih problema koji su doveli do zaostajanja njegovog razvoja, od gubitka ljudskih resursa do slabog upravljanja različitim prirodnim i kulturnim kapacitetima, što direktno implicira njegovu devastaciju. Treba napomenuti, da ruralni prostor Srbije predstavlja prostor mogućeg razvoja, odnosno veliki njegov deo je neiskorišćen i pored toga što poseduje potencijalne mogućnosti u pogledu razvijanja mnogih aktivnosti, naročito nepoljoprivrednih. Ovo se odnosi i na razvoj turizma kao delatnosti koja može imati značajan uticaj na ekonomsku, demografsku, socijalnu i funkcionalnu strukturu ruralnog prostora. Jedan od njegovih potencijalno perspektivnih vidova, predstavlja i lovni turizam. Lovni turizam je specifičan oblik turizma koji se razvija zahvaljujući želji lovaca da love i izvan svojeg lovišta, lovne jedinice ili čak izvan države, za šta plaćaju određene naknade. Karakteriše ga ekskluzivnost, doprinosi produženju turističke sezone, realizuje se u ruralnim područjima i doprinosi rastu ukupnih prihoda svih učesnika u njegovoj realizaciji.

Ključne reči: razvoj, lovni turizam, ruralna ekonomija, integralan.

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**CONTEMPORARY SIGNIFICANCE OF HUNTING
AND GAME ANIMALS USE IN TRADITIONAL FOLK MEDICINE
IN NW MONGOLIA**

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Summary: Hunting - traditional employment of native peoples of NW Mongolia. From May, 17, 2012 hunting defined by *The Mongolian Law on Animals*. Our material is collected 2013-2014 in Zavhan and Uvs Aymags of Mongolia. Wolf - most undesirable element of pastoral ecosystems of region and the most popular object of hunting. Decrease in a damage to husbandry - the main driver for hunting. The brigade from five hunters within five years has shooted 45 wolves. Each family loses for a year from wolves of 20-30 rams and goats. In the market carcasses of wolves (together with a skin) which as a rule send to Ulan-Bator are especially highly appreciated. The price for a skin reaches 100 thousand tugriks (USD 60). Export to China and Tuva. Hunting production is widely used in traditional folk medicine. Meat apply at treatment of respiratory organs. Some hunters suck fresh wolf blood. Siberian marmot - traditional and favorable object of hunting in Mongolia. Last year's population was sharply reduced. Therefore in 2012 the total protection of marmot has been legislated. In a reality the given interdiction is not so strong observed, because meat of marmot - a delicacy on a festive table of any family. Asian badger hunted mostly from the medical purposes: for treatment of throat cancer, at diseases of respiratory organs, stomach and liver. Catching period of badgers X-XI, or - if necessary - during other seasons. The basic way - digging holes. For a season the hunter normally bagged one-two badger. Market price for a live badger can reach 150 thousand tugriks (USD 80). It more than cost of a one ram. American mink has got in NW Mongolia as a result of natural migration from Tuva in the late eighties. Population in grows. A primary factor of success of invasion - predatory on muskrat. Wild boar inhabits reed "jungle" near to large reservoirs. Object of hunting. In folk medicine meat of Altain snowcock, Daurian partridge, black grouse, mountain hare, and muskrat is appreciated also.

Key words: game animals, hunting, fur, traditional medicine, Mongolia

Study was funded in part by of RFBR (grant 13-04-92217).

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ZNAČAJ SAVREMENOG NAČINA LOVA I DIVLJAČI ZA UPOTREBU U TRADICIONALNOJ NARODNOJ MEDICINI U MONGOLIJI

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Sažetak: Tradicionalni način lova naroda severo-zapadne Mongolije je od 17 maja 2012 uređen zakonski usvajanjem Mongolkog Zakona o životinjama. Materijal u ovom radu je sakupljen u period 2013-2014 u Zavhan i Uvs Aymags u Mongoliji. Vuk predstavlja najnepoželjniji element pastoralnih ekosistema regiona i najlovljeniju vrstu divljači. Glavni razlog izlova je smanjenje šteta u domaćinstvima. grupa od pet lovaca je tokom pet godina izlovila 45 jedinki vuka. Svaka porodica godišnje pretrpi gubitak 20-30 ovaca ikoza od strane vuka. na tržištu su veoma cenjeni vukovi, u celini sa kožom, koji se po pravilu prodaju u Ulan-Batoru gde su posebno cenjeni. Cena kože dostiže 100 hiljada tugriksa (60 US dolara). Vrži se i izvoz u Kinu. Produkti ulova se koriste i u tradicionalnoj narodnoj medicine. meso se koristi za lečenje respiratornih organa. Neki lovci čak isisavaju svežu vučiju krv. Sibirski mrmot je takođe tradicionalni i poželjan objekat za lov. Prošlih godina došlo je do naglog smanjenja brojnosti populacija. Zbog toga je 2012 zakonom zabranjen lov na ovu vrstu. U realnosti ovaj zakon se ne sprovodi, i meso mrmota se i dalje nalazi kao specijalitet u porodicama prilikom proslava. Azijski jazavac se najviše lovi u medicinske svrhe: za tretman kancera grla, bolesti respiratornih organa, želudca i jetre. Period izlova jazavaca je X-XI, a u slučaju potrebe i u drugim sezonama. Osnovni način izlova je pravljenje klopki. Po sezoni lovac izlovi jedan do dva jazavca. Tržišna cena živog jazavca dostiže 150 tugriksa (80 US dolara). To je više od cene ovna. Američka kuna naselila je područje severo-zapadne Mongolije kao rezultat prirodne migracije kasnih osamdesetih godina. Populacija je u ekspanziji. Osnovni factor koji je doveo do uspešne invazije je dostupnost plena. Divlja svinja naseljava tršćane predele u blizini velikih lovnih rezervoara. I divlja svinja je objekat lovaca. U narodnoj medicine još se cene snežni detlić, daurijska jarebica, crna patka, planinski zec.

Ključne reči: divljač, lov, krzno, tradicionalna medicina, Mongolija

Studija je delom finansirana od strane RFBR (grant 13-04-92217).

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THE PRESENCE OF BIRDS AND OTHER ANIMALS, THEIR DISPERSION AND SECURITY INDICATOR AT THE AIRPORT NIKOLA TESLA

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Summary: This paper comprises the analysis of the problem with presence of birds as well as other animals at the airport Nikola Tesla Beograd as well as activities of the Department of physical and technical protection of the airport from the birds and other animals to reduce the risk of bird strike to aircrafts. According to the evaluative indicators it can be clearly seen that the value at our airport is reaching the limit of about 0.3 bird strikes per 1000 operations (take-off and landing of aircraft), which clearly proves that we are below the international recommendations for collision of birds and aircraft ranging to 1 bird strike per 1000 operations.

Dispersion of the birds and other animals in 90.58% of cases was performed with acoustic systems (sirens, bioacoustics system and megaphone), in 8.27% of cases dispersion was performed with hand-held laser device, while dispersion by firing of weapons (Department of physical security) was performed in 1.15% of cases. Among the most problematic birds we can single out the birds from crow family (rook, black crow and jackdaw) and gulls (blue gull, river gull) - they have share of 86.14% of dispersing birds. Activity of birds was most expressed from May to October.

The presence of birds around airports is caused by the presence of places where they can reproduce, as well as the feeding base that is used in their feeding at certain times of the year.

Key words: Airport, birds, safety indicators

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**PRISUSTVO PTICA I DRUGIH ŽIVOTINJA, NJIHOVO RASTERIVANJE I
INDIKATOR BEZBEDNOSTI NA AERODROMU NIKOLA TESLA
BEOGRAD**

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Sažetak: Ovaj rad obuhvata analizu problema sa prisustvom ptica, kao i drugih životinja na aerodromu Nikola Tesla Beograd, kao i aktivnosti Odeljenja za fizičke i tehničke zaštite aerodroma od ptica i drugih životinja u cilju smanjenja rizika udara ptica u avione. Prema vrednosnim pokazateljima može se jasno videti da vrednost na našem aerodromu dostiže granicu od oko 0,3 a udara na ptica 1000 operacija (poletanja i sletanje vazduhoplova), što jasno pokazuje da smo ispod međunarodnih preporuka za sudar ptica i aviona u rasponu od 1 ptica na 1000 operacija.

Disperzija ptica i drugih životinja u 90.58% slučajeva je izvršena sa zvučnim sistemima (sirene, sistem bioakustike i megafona), u 8,27% slučajeva disperzija je izvedena sa ručnim laserskim uređajem, dok je disperzija od ispaljivanja oružja (Odeljenje za fizičko obezbeđenje) izvedena u 1.15% slučajeva. Među problematičnim pticama možemo izdvojiti ptice iz porodice vrana (gačac, Crna vrana i čavka) i galebovi (plavi galeb, rečni galeb) -koji imaju učešće od 86.14% u rasterivanju ptica. Aktivnost ptica je najviše izražena od maja do oktobra.

Prisustvo ptica oko aerodroma uzrokovano je prisustvom mesta gde mogu da se razmnožavaju, kao i prisustvo hrane u određenim periodima godine.

Ključne reči: aerodrom, ptice, indikato bezbednosti

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MICROECONOMIC ANALYSIS OF GAME POPULATION MANAGEMENT IN HUNTING GROUNDS

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Summary: Microeconomic approach to economic considerations implies focusing on business developments of the operators or their specific activities. This analysis provides insight into financial part of management of *Barajevska reka* hunting ground in order to comprehend the growing costs and harvest value of the most abundant game species in the hunting ground. The planned harvest value is EUR 20.529 or 18.23% of the total value of the breeding stock. Harvested big game (roe deer and wild boar) accounts for 66.67% of the total planned harvest, while small game accounts for 33.33% of the planned harvest. The planned roe deer harvest accounts for 62.85% of the harvest value. Management result values in 2013 show that thus evaluated game reports operating loss with cost-effectiveness ratio of 0.78, production profitability rate of -28.87 and loss of EUR 43.68 per 100 hectares of hunting area. This clearly indicates that funding of hunting ground management requires provision of funds from other sources, which in this case means from membership of hunters. Indirect costs of management for hunting ground users account for 62.1%, while direct costs of game growing and maintaining hunting grounds account for 37.9% of total management costs.

Profit in the production may be realized through implementation of big game harvest plan in the market and fulfilment of the small game harvest plan by hunters who are the members of the association. Significant enhancement of the economic performance of game population management can be made by improving the game management by increased share of roe deer in the medal, reducing losses and increasing real growth in some game species within the acceptable biological limits.

Key words: game, hunting ground, management value, expenditures

Introduction

Microeconomic approach to economic considerations implies focusing on business developments of the operators or their specific activities. In that context, microeconomic analysis of game species management in a hunting ground assumes focusing on those populations that are exploited in the hunting ground and that are economically significant for the hunting ground users. Goal of any operator and of hunting ground user likewise is to achieve maximum profit with the lowest possible costs. Changes in hunting legislation are gradually modifying the hunting sector. The development of hunting in Serbia is influenced by the transformation of social structure in accordance with the political processes of joining the European Union, as well as international conventions (Adamič et al., 2006). With entry into force of the new Law on Game and Hunting (2010), all hunting ground users are indirectly forced to gradually transit to a market-oriented operation system. In order to achieve the highest possible financial effects of hunting ground management, they must manage the game efficiently and on economic principles. To that end, the hunting ground users will be forced to take all management measures in order to maintain the game population in the hunting ground and its optimal use, in order to preserve permanency in management and prevent the reduction in its abundance in the hunting grounds but also to evaluate it according to economic principles. The presence of certain game in the hunting grounds and its spatial distribution are primarily influenced by natural factors, but the influence of anthropogenic factors is also quite pronounced, especially for some species (Popovic et al. 2012A, 1996, 1997, 1997b; Popovic 2008;

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Popovic 2006; Gajic et al .1997; Bogdanovic et al., 1996; Popovic and Bogdanovic 2001; Popovic and Gajic 1996). The present analysis provides insight into the financial part of hunting ground management in order to comprehend the economic effects of growing and harvesting the most abundant species in the hunting ground. It is of economic interest to grow as many individuals of certain game species as possible, and in big game also the appropriate age and sex structure in order to achieve the highest possible trophy value. The revenue is primarily influenced by pricelist (for tourists, members of hunting associations, pricelist prescribed by the Minister for the payment of fees for the exploitation of game) according to which the game animals are sold, as well as gender and trophy structure of harvested big game species. As the economic results of game management depend, on the one hand, on characteristics of the hunting ground (size, characteristics of natural hunting grounds and present game species in the hunting ground), and on the other hand, on the manager, analysis of economic effects is based on a typical hunting ground of hilly relief configuration. This is *Barajevska reka* hunting ground managed by *Mića Popović* hunting association from Barajevo.

The aim of this paper is to carry out a microeconomic analysis of the management of small game (rabbit, pheasant, quail, etc.) and large game (roe deer, wild boar) populations in the *Barajevska reka* hunting ground. The analysis indicated the indirect costs of management which hunting ground users are subject to in accordance with applicable legislation, and the possibility of improving the economic effects of using different game species.

Materials and Methods

The research covered game hunting bag records in *Barajevska reka* hunting ground in the business year 2013/14, as well as expenditures related to the hunting ground management. Complete business activities of users of this hunting ground (*Mica Popovic* hunting association Barajevo) during this hunting year. *Barajevska reka* hunting ground stretches over the areas of forests, land and water of Barajevo Municipality, Belgrade County, the Republic of Serbia, on a total area of 21,312 ha. Hunting area of the hunting ground is 15,910.00 ha or 74.65% of the total hunting ground surface. The hunting area is oval in shape with the lowest above sea altitude of 100 m and 408 meters to the maximum. Arable land covers an area of 12,812 hectares or 63.27% of the total hunting ground surface area.

Game abundance and realized harvest are taken from the annual management plan of the hunting ground and the records that must be kept by the hunting ground user on the basis of the Law on Game and Hunting. The value of the breeding stock and the value of the planned harvest in 2013/14 were determined according to the *Decision on determining the amount of fees for the exploitation of game species protected by closed season and the amount of fees for hunting ticket for the hunting year 2014/2015* (<http://www.mpzss.gov.rs/vest/541/>) passed pursuant to Article 23(2) of the Law on State Administration (Official Gazette of the RS, No 79/05, 101/07 and 95/10) and Article 80(6), and Article 81 of the Law on Game and Hunting (Official Gazette of the RS, No 18/10). In the income of the hunting ground user, the value realized from the sale of game in the hunting year 2013/14 is presented. Management costs were obtained by summing up direct costs of growing the game and the part of general costs which belong to the hunting ground user according to the applicable legal regulations relevant for the hunting ground users.

Financial position of revenues from the hunting ground management were projected for cases when game bags are charged according to the price list of the Hunting Association of Serbia (www.lovacki-savez-srbije.org) in terms of prices for "members of hunting association", "tourist hunters" as well as prices according to the possibility of realization of certain game species in the market.

Results and Discussion

Total value of the stock of hunting game species according to the *Decision on determining the amount of fees for the exploitation of game species protected by closed season and the amount of fee for hunting ticket for the hunting year 2013/2014* is EUR 112,602 (Table 1). This value does not include pheasant since it is not provided in the given pricelist, as it is a species that is reintroduced to the hunting areas from pheasant farms. The planned harvest value is EUR 20.529 or 18.23% of the total value of the breeding stock. Harvested big game (roe deer and wild boar) accounts for 66.67% of the total planned

harvest, while small game accounts for 33.33% of the planned harvest. The planned roe deer harvest accounts for 62.85% of the harvest value.

As for the percentage of realisation of the harvest plan, it can be seen in Table 1 that roebucks account for 94.34%, does and fawns 64.91%, boars 87.50%, hare 79.21% quail 55.56%, while in some of the planned game species there is no harvesting (woodcock, teal, collared dove).

In the *Barajevska reka* hunting ground, total value of the roe deer breeding stock of 700 animals in 2004/05 amounted to EUR 60,552 (Tomic et al. 2007), and now according to this pricelist it is EUR 52,236. The value of the roe deer population stock was estimated at the average price of individuals as determined by weighting the prices of heads of different ages and different harvest and trophy value (Tomic et al., 2005). The current value of roe deer stock in the same hunting ground is smaller and according to the above mentioned pricelist it amounts to EUR 52,236 (Table 1). This reduction in the stock value is influenced by the applied pricelist although roe deer abundance is exactly the same with minor differences in the structure of the population compared to the one observed in the study by Tomic et al. (2005). In this hunting ground, roe deer (*Capreolus capreolus*), from both biological-ecological and economic point of view, represents one of the most important species, what can be also said for the hunting economic activity of Serbia. This species inhabits ecologically different habitats and is present in approximately 90% of the hunting area of the Republic of Serbia (Popović and Gačić, 2005; Popović et al., 2006). Annual harvest value of this game species is over USD 800,000 (Ranković and Popović, 2002). This economic benefit derives from all the determinants of the hunting value (harvest, trophy and meat).

Table 1. Game stock abundance in the hunting area, planned harvest and their value in 2013/14

No.	Game species – Breeding stock	Breedin g stock - heads	Stock value (Euro)	Planned harvest - heads	Value of planned harvest (EUR)	Realised harvest - heads	Value of realised harvest (EUR)	% of realised harvest
1.	Roe deer - roebuck	263	35640	71	9621	67	9079	94.37
2.	Roe deer - doe	263	11880	57	2575	37	1671	64.91
3.	Roe deer - fawn	174	4716	26	705	26	705	100.00
4.	Roe deer - total	700	52236	154	12901	130	11455	84.42
5.	Wild boar - wild boar	3	474	2	316	2	316	100.00
6.	Wild boar - sow	6	271	5	226	3	136	60.00
7.	Wild boar - gilt	9	244	9	244	9	244	100.00
8.	Wild boar - total	18	989	16	786	14	696	87.50
9.	Hare - <i>Lepus europaeus</i> Pall.	1750	31620	250	4517	198	3578	79.21
10.	Mallard - <i>Anas platyrhynchos</i> L.	400	3614	40	361	25	226	62.50
11.	Teal - <i>Anas crecca</i> L.	150	677	15	68	0	0	0.00
12.	Woodcock - <i>Scolopax rusticola</i> L.	500	4517	40	361	0	0	0.00
13.	Wood pigeon - <i>Columba palumbus</i> L.	1500	4064	100	271	22	60	22.00
14.	Japanese quail - <i>Coturnix coturnix</i> L.	5000	9017	450	812	250	451	55.56
15.	Turtle dove - <i>Streptopelia turtur</i> L.	2500	4509	200	361	30	54	15.00
16.	Collared dove - <i>Streptopelia decaocto</i> Friv.	1500	1359	100	91	0	0	0.00
17.	Total big game (1-6)	-	53225	-	13687	-	12151	-
18.	Total small game (7-14)	-	59377	-	6842	-	4369	-
19.	Total (1-14)	-	112602	-	20529	-	16520	-

Table 2 shows that the value of management results in 2013 amounted to EUR 24,071, out of which value of sales of roe buck trophies, meat and hunting services accounts for 52.22%, while the value

of roe deer and fawns accounts for 18.11%. This species in total accounts for 63.4% of the management value. Especially good ratio in management of this species, good management, but also proximity to a large city – Belgrade, have influenced on the fact that the largest roe deer harvest was realised through tourist hunting. The wild boar harvest value accounts for 2.89% of the total revenue from management. Small game, including hare and pheasant, accounts for 33.71% of the total management value.

Analysis of expenditures of hunting ground users (Table 2) shows that the direct costs of management account for 37.9%, while indirect costs of management account for 62.1% of the total costs. Building and maintenance of hunting facilities, planting fields for game and feed for game account for 15.31% of total costs. Indirect costs that burden the hunting ground user with 39.17% are costs of two employees performing the jobs of a gamekeeper and a professional hunting ground manager according to the Law on Game and Hunting (2010), while fees for game and veterinary certificates account for 10%.

Table 2. Economic results of game management in the hunting year 2013/14 and projected results of the collection of payments for game using different pricelists

Elements	Value of management results in 2013/14		Projected management value					
			according to pricelist for hunting association members		according to pricelist for tourist hunters		according to possibility of realization in the market	
	Amount Val.	%	Amount Value	%	Amount Val.	%	Amount Val.	%
A) Value of production (EUR)	24071	100.00	14711	100.00	47686	100.00	31817	100.00
Roebucks - trophy and meat, hunting services	12569	52.22	5805	39.46	18513	38.82	15700	49.34
Does and fawns	2692	11.18	995	6.76	2852	5.98	3550	11.16
Wild pigs	695	2.89	390	2.65	1300	2.73	1300	4.09
Hare	1960	8.14	1960	13.32	6534	13.70	3578	11.25
Other small game	6155	25.57	5561	37.80	18487	38.77	7689	24.17
B) Costs of production (EUR)	31021	100.00	31021	100.00	31021	100.00	31021	100.00
Direct costs of management:								
Hunting facilities, animal feed	4748	15.31	4748	15.31	4748	15.31	4748	15.31
Maintenance of field vehicles and trailers	3637	11.72	3637	11.72	3637	11.72	3637	11.72
Insurance damage caused by wildlife,	2732	8.81	2732	8.81	2732	8.81	2732	8.81
Processing trophies	640	2.06	640	2.06	640	2.06	640	2.06
Indirect costs of management:								
Salaries for 2 workers	12150	39.17	12150	39.17	12150	39.17	12150	39.17
Bookkeeping services	1202	3.87	1202	3.87	1202	3.87	1202	3.87
Maintenance costs of office space	2391	7.71	2391	7.71	2391	7.71	2391	7.71
Veterinary certificates	1017	3.28	1017	3.28	1017	3.28	1017	3.28
Compensation for wild game	2053	6.62	2053	6.62	2053	6.62	2053	6.62
Charges, taxes	451	1.45	451	1.45	451	1.45	451	1.45
A-B Profit (EUR)	-6950	-	-16310	-	16665	-	796	-
I Cost-effectiveness ratio	0,78		0,47	-	1,54	-	1.03	-
II Production profitability rate (%)	-28.87	-	-110.87	-	34.95	-	2.50	-
III Profit per 100 ha of hunting area (EUR)	-43.68	-	-102.51	-	104.75	-	5.00	-

Values of the management results in 2013 show that based on thus evaluated game the business operation recorded losses and cost-effectiveness ratio of 0.78 and production profitability rate of -28.87 production, and loss of EUR 43.68 per 100 ha of hunting area. This clearly indicates that funding of hunting ground management requires provision of funds from other sources, which in this case means from membership of hunters.

In case of the projected state of the realisation of the management value according to the pricelist for members of hunting associations, the loss would increase and the cost-effectiveness ratio would be 0.47, while the production profitability rate would be -110.87.

The projected state of the management evaluation according to pricelist for tourist hunters would make profit with the cost-effectiveness ratio of 1.54. However, in the current market conditions and poor financial situation of hunters that is impossible to achieve.

As the third projected state, the possibility of realization of game on the market was presented, where fulfilling the plan of roe deer and wild boar harvest was planned, which was not fulfilled in 2013, with their share of 64.59% in the total value of management. This is by 1.7% less than the current realisation. Also, the fulfilment of the plan of realization of small game would magnify the income and it would account for 35.41% of the total value of management. Such realisation of management would make profit, with the cost-effectiveness ratio of 1.03, the production profitability rate of 2.50 and profit of EUR 5 per 100 ha of hunting area.

From the obtained results, it can be concluded that the abundance and density of the analysed game species per hunting districts are not uniform, and also that the extent of shot individuals is not harmonized with its number (Popović, 2006; Popović et al. 2008; Beuković et al. 2009; Popović et al. 2012a). This is one of the main factors that causes the unsatisfactory game abundance in Serbia. The most abundant game species analysed in this paper is brown hare, whose number has been decreasing in the last years (Popović et al. 2012a) and it is below its number in the surrounding countries, such as Hungary or Austria (Popović et al. 2012a; Hackländer, 2012).

By analyzing the factors influencing the results of management of populations of the economically most important species of game in the hunting grounds, in order to improve the economic effects of major hunting game species (Tomic et al, 2007) concluded that the activities must be directed to those factors which directly or indirectly influence the management results. First of all, losses should be reduced during game reproductive season, and the exploitation rate of certain game populations should be adjusted, taking into account specificities of different regions.

Significant enhancement of the economic performance of game population management can be achieved also by improving the game management also by improving the way of management, that is, by moving relevant parameters (growth rate, losses, trophy quality) within the acceptable biological limits. This is indicated by the research in roe deer breeding stock in Serbia during the hunting financial year 2003/4 (Tomić and Popović, 2005). Based on the increase in annual growth rate from 25 to 31%, annual roe deer harvest value would increase by nearly 9%. Increasing the share of roe deer harvest in the "medal" from 14.33 to 19%, would increase the income from trophies by 23% and total harvest value by 18%. Finally, reducing the losses from the realized 10.31 to realistically possible 07.31 would increase the abundance to 3,308 animals. Should these heads be realized by harvesting the existing structure, the revenue would be 75% higher than that achieved in the observed year.

In order to increase the financial basis of hunting associations the hunting tourism must be increased. Hunting tourism, as a very specific branch of tourism, is a very important source of income in hunting (Beuković et al. 2004). However, the problems faced by foreign tourists are related to the inability to take trophies and game meat out of our country, which is a serious problem in hunting economy of our country and causes large economic losses.

Provision of revenues of the association cannot be expected from the increase in number of hunters or increase in membership fee from which it is financed or from hunting ground management. On the basis of the research by Popovic et al. (2012b) the number of hunters in Serbia is currently in decline, and the reasons for reducing the number of hunters in Serbia are reflected in difficult financial situation, pronounced rural-urban migrations, old age hunters, poor interest of young people in hunting, decreased abundance of the game and pressure of the anti-hunting organizations on the hunting sector.

Conclusions

Based on the financial analysis of hunting ground management in order to comprehend the economic effects of growing and harvesting of the most abundant game species in the hunting ground the following has been established:

The value of the planned harvest is EUR 20,529 or 18.23% of the total value of the breeding stock. Big game (roe deer and wild boar) harvest accounts for 66.67%, while small game account for 33.33% of the planned harvest. Planned roe deer harvest accounts for 62.85% of the harvest value.

The value of management results in 2013 amounted to EUR 24,071, out of which value of sales of roe buck trophies, meat and hunting services accounts for 52.22%, while the value of roe deer and fawns accounts for 18.11%. This species in total accounts for 63.4% of the management value. The harvest plan has not been fully realised in some game species.

Especially good roe deer management, good management, but also proximity to a large city – Belgrade, have influenced on the fact that the largest roe deer harvest was realised through tourist hunting. The wild boar harvest value accounts for 2.89% of the total revenue from management. Small game, including hare and pheasant, accounts for 33.71% of the total management value

Values of the management results in 2013 show that value of evaluated game causes business loss for hunting ground users with cost-effectiveness ratio of 0.78, production profitability rate of -28.87 production and loss of EUR 43.68 per 100 ha of hunting area. For the co-funding of hunting ground management, resources must be provided from other sources, which in this case means from membership of hunters.

Indirect costs of management for hunting ground users account for 62.1%, while direct costs of game growing and maintaining hunting grounds account for 37.9% of total management costs.

In order to realise profit from game management, harvest plan accomplishment must be pursued as well as the realization of big game harvest according to the tourist pricelist, as well as the fulfilment of the plan and realization of small game harvest according to pricelist for members of the hunting associations, and to a lesser extent according to the price list for tourist hunters.

Significant improvement of the economic performance of game population management can be achieved also by improving the ways of game management, by increasing the share of roe deer in medal, reducing losses and increasing real growth rate in some game species within the acceptable biological limits.

Acknowledgments

The authors wish to express gratitude to the Ministry of Education, Science and Technological Development of the Republic of Serbia which financed these investigations within the project TR-31009 "Modern concepts of managing game animals populations aiming to greater economic valorization".

References

1. Адамич, М., Рапајић, Ж., Поповић, З., Куновац, С., Опривица, М., Солдо, В., Марковић, Б., Маунага, Рада., Мићевић, М., Илић, В. (2006): Угрожене врсте дивљачи у Босни и Херцеговини. Бања Лука, pp.94.
2. Beuković, M., Popović, Z., Zeremski, M., Đaković Dara (2004). Sadašnje stanje i perspektiva lovnog tuizma u Vojvodini. Međunarodni simpozijum „Savremene tendencije u turizmu, hotelijerstvu i gastronomiji 2004“. Lovačke novine XI 2004, st. 24-26.
3. Gajić, I., Popović, Z., Bogdanović, V. (1997): The population dynamics of roe deer (*Capreolus capreolus* L.). *Ekologija* 32(1): 145-154 Beograd.
4. Hackländer, K. (2012): Sustainable management of European hares in lower Austria. International symposium on hunting "Modern aspects of sustainable management of game population". Proceedings, 7-8.
5. <http://www.mpzss.gov.rs/vest/541/> Одлука о утврђивању висине накнаде за коришћење ловостајем заштићених врста дивљачи и висине накнаде за ловну карту.
6. [http://www.lovacki-savez-srbije.org/Cenovnik divljači 2013/14](http://www.lovacki-savez-srbije.org/Cenovnik%20divljači%202013/14)
7. Perišić, P., Popović, Z., Đorđević, N., Živković D. (2009): Faktori koji utiču na ekonomske efekte gazdovanja važnijim vrstama lovne divljači. Međunarodno savetovanje o lovstvu, 48-59. Žagubica 2009.
8. Popović Z. (2006): Gazdovanje populacijama divljači u lovištima lovačkog saveza Srbije. *Biotehnologija u stočarstvu*, Vol 22, Special issue, 113-128.
9. Popović Z., Gačić D. (2006): Trofejna vrednost i starost srmdača u različitim tipovima lovišta. *Savremena poljoprivreda*, Vol. 55,3-4; str. 1-5; Novi Sad.
10. Popović, Z. (2006): Uzroci gubitaka srna (*Capreolus capreolus* L.) i njihov uticaj na gazdovanje Naučno-stručno savetovanje agronoma Republike Srpske. Proizvodnja hrane u uslovima evropske zakonske regulative. Zbornik sažetaka str.107. Teslić 2006.
11. Popović, Z., Beuković M., Đorđević, N. (2008): Brojnost i stepen korišćenja populacija divljači u lovištima lovačkog saveza Srbije. *Biotehnologija u stočarstvu*, Vol.24, 11-23.

12. Popović, Z., Beuković, M., and Đorđević, N. (2012): MANAGEMENT BROWN HARE (*Lepus Europaeus* Pall.) POPULATION IN SERBIA. International symposium on hunting "Modern aspects of sustainable management of game population". Proceedings 1-6.
13. Popović, Z., Bogdanović, V. (2001): Uzroci gubitaka i njihov uticaj na gazdovanje populacijom srneće divljači. Međunarodni simpozijum "Naučna dostignuća u stočarstvu 2001" Savremena poljoprivreda, br.3-4; str. 243-245; NoviSad.
14. Popović, Z., Bogdanović, V., Gajić, I. (1996): Analiza promene brojnosti zeca u našoj zemlji. Zbornik radova sa savetovanja u Prokuplju i Kikindi 1995., str. 121-132. Lovački savez Jugoslavije, Beograd.
15. Popović, Z., Bogdanović, V., Gajić, I. (1997a): Analiza populacije jarebice poljske i mere poboljšanja. Zbornik radova sa simpozijuma "Zec i jarebica u savremenim agroekosistemima" str. 107-113; Novi Sad.
16. Popović, Z., Bogdanović, V., Gajić, I. (1997b): The influence of climatic factors on the participation of young in the hare's population (*Lepus europaeus* Pall.) Ekologija 32(1) 139-144. Beograd.
17. Popović, Z., Đorđević, N., Perišić, P., Beuković, M. (2006): Plodnost, gubici i realni prirast populacije srna. Simpozijum «Stočarstvo, veterinarstvo i agroekonomija u tranzicionim procesima» St. 96 . Herceg Novi 18-25 juni 2006.
18. Popović, Z., Gajić, I. (1996): Analiza promena brojnosti jarebica poljskih u našoj zemlji. Zbornik radova sa savetovanja u Prokuplju i Kikindi 1995., str. 7-16, Lovački savez Jugoslavije, Beograd.
19. Popović, Z., Lavadinović, V., Djordjević, M., Beuković, M., (2012): State and trends of the hunting sector in Serbia as the base for the sustainable game management. International Scientific Conference. Forest in the future Sustainable use, risks and challenges 4th-5th october 2012 Belgrade. Invitation papers. Pp. 205-213.
20. Ranković, N., Popović, Z. (2002): Dinamika odstrela i vrednost izlova nekih vrsta divljači u Srbiji. «Međunarodni simpozijum Stočarstvo i agroekonomija u procesima tranzicije» Savremena poljoprivreda, br.3-4; str. 195-198; Novi Sad.
21. Tomić R., Popović Z., Perišić P. (2007): Uticaj promene uzgojno-eksploatacionih parametara na ekonomske efekte gazdovanja srnećom divljači. Savremena poljoprivreda, br.1-2; str. 212-217; Novi Sad.
22. Tomić, R., Popović, Z., Perišić, P.:(2005) Ekonomski efekti gazdovanja srnećom divljači u multifunkcionalnom razvoju ruralnog područja Srbije. Međunarodni naučni skup «Multifunkcionalna poljoprivreda i ruralni razvoj». Tematski zbornik, 292-299.
23. Закон о дивљачи и ловству („Службени гласник РС”, број 18/10).
24. Закона о државној управи („Службени гласник РС”, број 79/05, 101/07 и 95/10)

**FIBER LEVEL OF NATURAL FEED IN STOMACH CONTENT OF BROWN HARE
(*LEPUS EUROPAEUS*) FROM OPEN FIELDS OF AGRO-BIOTOPE**

Beuković M.¹, Đorđević N.², Beuković D.¹

Summary: By the disappearance of steppe as ideal habitat for brown hare, the species has successfully adapted to agro biotope, or to areas under large arable land. The hares prefer a habitat of open fields with hedgerows and woodlots near arable farmland, as they are herbivores and mainly eat wild herbs, grasses and agricultural crops. European hares can eat a lot of vegetation, rich in cellulose, which is a part of the brown hares' grass-based diet, which is difficult to digest in first time passing through digestive tract, which is monogastric. While lying in their forms during the day the hares pass soft droppings, which contain the undigested vegetation. They eat these soft pellets, a process called coprophagy so they can properly digest their food and get the maximum nutrition from it. One of the quickest and easiest ways to estimate the composition and quality of brown hare feed from open fields of agro-biotope is by examining the stomach contents of hunted animals. In our research, samples of gastric contents of 115 brown hare were collected from eight different locations in Vojvodina, during the autumn hunting season 2012th. We analyzed the age of hunted animals and the fiber content in the stomach (NDF and ADF). The aim of this paper was to determine fiber level in stomach content of brown hare from open fields in Vojvodina. The NDF level was in range 28.45% to 29.86% depending on age, level of ADF also depended on age and it was 18.66% to 20.35%. Between age groups there are no statistical significant differences. The highest level of NDF was in up to 1 year age old group of brown hare. It was observed that the level of the ADF increased by aging. Correlation between NDF and ADF in the stomach contents of brown hare was positive ($r = 0.70$) and can be assessed with moderate connection.

Key words: brown hare, NDF, ADF, stomach content, natural feed

Introduction

Intensification of agriculture changed the typical habitats of brown hare, first of all through drastic increase of arable land, with intensive usage of pesticides, and, at the same time, with reduced areas under forage crops. For the hunting areas of Serbia, brown hare (*Lepus europaeus* Pall) is definitely the most interesting species of small hairy hunting game. Its areal distribution and presence in certain hunting areas is under the influence of natural conditions such as climate (Beukovic et al 2013), diseases and predators, including, at an increased content, anthropogenic factors (Beukovic et al 2011.). Due to the disappearance of steppes brown hare inhabits arable land. Such a habitat expresses deficiency in diet because of the intensification of agriculture. Natural diet of hares depend on characteristics of the hunting ground, on the degree of human activities and, mostly, upon the season. The quickest and the easiest way for judging the content and the quality of natural food is the examination of stomach content of hunted animals. As for the influence of season, there is evident lack of all dietary nutrients during winter period, especially at the time of low temperatures, high snow and icy crust. Apart for the winter time, another great problem for the feeding of hare is in the period after harvest when, up to that moment dominant feed on the arable land disappears, and, at the same, the natural production of feed on pastures is significantly reduced due to the summer drought. This phenomenon is called "harvest stress" and it could be extremely detrimental for the brown hare populations which live on great arable areas under monocultures. Feeding of hare includes the consumption of hardly digestible food that contains a lot of crude fiber. Caecum is a part of

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the digestive system where through the fermentation of fiber from food it enables the usage of dietary matters from easily available food as mentioned before and therefore it requires the presence of saprophytic micro flora, which will enable digestion. The caecum has specialized properties that allow brown hare to be fed a wide range of feeds. In the young brown hare, whilst suckling, the caecum remains relatively free of microorganisms until the commencement of solid food intake. During the suckling period the young leverets depends largely on protein and fat in the mother's milk which has very low lactose content (around 1% of milk). Milk has a major bacteriostatic role as it contains a high milk fat that is high in C8 and C10 fatty acids which suppresses microbial colonization of the anterior part of the tract (Cole et al. 1982). The stomach of brown hare consists of one chamber and it is relatively small, volume of 180-200 cm³. Its weak musculature brings to the fact that the food inside it moves exclusively under the pressure of new quantities of swallowed food, therefore, brown hare feeds according to the system small but frequent.

The aim of this paper is to determine the nutritive value of naturally available food from agro biotypes of Vojvodina upon the results of the analyses of stomach content. The parameters of stomach content of crude fiber (NDF and ADF) will be examined by the methods of chemical analyses. The results obtained will be afterwards compared to the results of other authors from the region, since the investigations of this kind have not been performed in Serbia earlier.

Material and Methods

The investigation was conducted in autumn 2012, during the hunting season. The brown hares were collected during hunting and afterwards grouped, marked and determined by sex and the samples of stomach were taken from every animal shot that hunting day. The stomach samples were then kept marked and frozen (-20°C) in separated bags until the preparation for analyses. The investigations were performed in the hunting areas in Vojvodine, on the localities near Bačka Topola, Gložan, Donji Petrovci, Voganj, Bačka Palanka, Kraljevci, Novo Miloševo, and Sonta.

In the laboratory of the Department of animal husbandry of the Faculty of Agriculture in Novi Sad, there were performed analyses of humidity, NDF and ADF. The procedure for the determination of crude humidity included the drying of the stomach content at 63 °S during 24hrs. Then the total humidity was determined by additional narrowing of temperature at 105⁰S 5-8hrs, for hygroscopic humidity. Determination of acid detergent fiber (ADF) was performed using the technique of filter bags (Ankom 2000). This method determines acid detergent fiber, which is the residue after digestion with H₂SO₄ and CTAB (cetil trimetilamonium bromide). The residues of the fiber are mainly cellulose and lignin.

Hares eyes were taken after hunting and sent to the laboratory of Hunting Association of Vojvodina, for testing. After extracting of the lenses, fixation was done for 3 days in 10% formalin solution. Then the lenses were dried at 37°C for 72 hours. After drying, the measurements were carried out on the analytical scale, precision of 1 mg. (Šelmić et al, 1999). The method of determining the age structure of the population of hare by the measurement of the mass of intraocular lens is based on the fact that the lens of the eye grows throughout life, much more intense during the first and second year of life, after which its growth slows (Lord, 1959; Rieck, 1962; Šelmić, 1984; Suchentrunk et al., 1991).

Results and Discussion

Table no. 15 shows "The results of examined analyses of variance and the tests of significance of age" where you can notice the lack of statistically important difference if the values are grouped according to the age. It can be noticed that, if the unknown age of hares is omitted, the values of SP decrease with the age, which is contrary to the values of ADF which are increasing with the increased age of hares. With hares up to 3 months of age the level of NDF in the stomach content was 28.45% . The mentioned value is only half a percent higher in comparison to the values obtained for hares of 3-6 months or one year of age, with noted values of

Table 1. The results of examination of analyses of variance and test of significance in comparison to the age

Age	DM %	NDF %	ADF %
Up to 3 months	70.76 ^a	28.45 ^a	18.66 ^a
3-6 months	72.36 ^a	27.88 ^a	18.87 ^a
Up to 1 year	70.85 ^a	27.97 ^a	20.03 ^a
Over 1 year	71.46 ^a	29.86 ^a	20.35 ^a

Super script: aa, not significant, $p > 0.05$

NDF of 27.88% and 27.97%, respectively. The highest level of NDF was seen in the group of hares older than 1 year, which was expected. The situation is similar for the level of ADF with the highest level of ADF in the group older than 1 year and it was 20.35%. And then, looking the values of younger age groups, the level decreased. In the first and in the youngest age group the recorded level of ADF was 18.66%, which is a difference of less than 2%. Although there were no significantly important differences, it was noticed that the NDF fraction containing hemicellulosis and which is more available, was more present in the stomach content of brown hares in the age group of up to 3 months of age, than in the groups of 3-6 months and up to 1 year of age. This could point out that the younger hares Preferably choose and consume fine grass than the dried ones. On the other hand, NDF fraction which consists of lignin and cellulose is the highest in the oldest age group with hares older than 1 year of age. This, once again, points out the correctness of the statement of selective feeding.

Table 2 – Correlation connection of variables

	DM (r)	NDF (r)	ADF (r)	Months (r)
DM	1.00	0.06	-0.04	-0.01
SP	0.38	-0.39	-0.30	-0.25
NDF	0.06	1.00	0.70	0.15
ADF	-0.04	0.70	1.00	0.15
Months	-0.01	0.15	0.15	1.00

The results of correlation analyses are given in Table 2: Correlation connection of variables” in which it can be noticed that ADF and NDF are positively correlated ($r=0.70$) and can be connected with moderate connectivity of variables. Grasses and legumes which are available for the feeding of hares during that period were in the period of blooming or in the period of post formation of leaves when the level of NDF is over 65% in legumes or 51% in grasses, while the level of ADF is over 41% both for legumes and grasses, respectively (Van Soest, 1982). Influence of weather conditions can significantly reduce the concentration of available crude nutritive matters. Significant losses of nutritive matters occur due to the rain. The content of DM in the plant increases with aging, but its digestibility and usability. However, as it has already been mentioned earlier, with the conditions that prevail in agro biotype of Vojvodina with frequent monocultures, brown hares are limited to a smaller number of plant species, total of around 14, while under pasture-steppe conditions it counts up to 37 plant species (Frylestam 1986). Reichli et al. (2006) investigated brown hares in Austria upon the samples of stomach content from February, May, August and November. The authors found the domination of crops in the autumn and winter nutrition of hares, first of all winter wheat (51%), and then nutrients provided by hunters (plants with roots, sugar beet, carrot.). The share of weeds in this period during the mentioned months is less than 5%. Analyses of the stomach content in February showed that, apart from wheat, sugar beet and carrot were present in about 91% of the total meal. During spring nutrition the stomach content of brown hare was dominated by crops (83%), soya being the first, while in August the most consumed were wild plant species, especially after the harvest of cereals. Katona et al. (2010) points out the fact that hares have small habitats within the range of 35– 100 hectares in Pannonian lowland, citing the papers (Homolka 1985, Kovács i Búza, 1988) and preferring different cultivations which contribute to the variety of

feeding. The results obtained by Katona et al. (2010) show that the brown hares do not limit themselves to one cultivated field, but go searching for food in different areas. Hence the need to create a system of heterogeneous agricultural habitats which would enable variety in hare feeding. The same authors mention that meadows, different non cultivated areas with grass and beans and with wild vegetation on the boundaries contribute to the variety of nutrition. Elder berries, which grow on boundaries, also represent hares' food of preference. Winter wheat which could be found in smaller parts during the period of autumn-winter also provides a good source of food, in the absence of wild flora (Katona et al. 2010). Stott et al. (2008) state that leverets use their small legs for tearing and pulling down the branches, while hares peel off the bark from the plants, which enables efficient usage of carbohydrates placed in the NDF fraction. Garcia et al. studied the effect of fiber sources to the digestibility of cell walls and to the speed of passing of digest through the small intestine of leverets. They noticed that the fiber source influences the intake of DM, and the digestibility of DM, NDF, ADF and NSP. Moreover, Björnhaug et al. (1981) came to the conclusion that one of the functions of the digestive system in rodents is to quickly expel the food that is difficult to digest and to keep easily digestible food which is further decomposed in the colon. The food which is more difficult to digest may represent a burden for the body reducing the animals' motoric abilities which have to function in a case of danger, especially when meeting their main predator, the fox. If we compare the frequency of meeting hare and fox and the frequency in intestine disturbances cause by fiber which is difficult to digest (feed with a lot of lignin and pectin), the hare is in a worse position and the problem mentioned might reduce its chances for survival.

Conclusion

- Considering from the age of brown hare, there is no statistically significant difference regarding the dry matter, crude proteins, crude fiber ADF and NDF in the stomach content. However, it is obvious that the level of NDF is reduced as the hares become older, while the level of ADF increases.
- Correlation relationship of the level of crude protein and dry matter in the stomach content is positive ($r=0.38$) and it can be marked as weak.
- There is negative correlation for crude proteins in stomach content in comparison to the level of NDF, ADF and age (expressed in months, while the mentioned values ($r=-0.39$; $r=-0.30$; $r=-0.25$) can also be marked as weakly connected.
- Stomach contents of ADF and NDF are positively correlated ($r=0.70$) and can be marked as modestly connected variables.

Acknowledgment

This work was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Grant No. 3 TR-31009.

References

1. Beuković, M., Đorđević, N., Popović, Z., Beuković, D., & Đorđević, M. (2011). Specifičnosti ishrane zeca (*Lepus europaeus*) kao uzrok smanjenja brojnosti populacija. *Savremena poljoprivreda*, 60(3-4), 403-412.
2. Beuković, M., Beuković, D., Popović, Z., Đorđević, N., Đorđević, M. (2013). Uticaj klimatskih faktora na procenat mladih u populaciji zeca (*Lepus Europaeus* P.) u Bačkoj. *Acta veterinaria*, 63(1), 111-122.
- 3.
4. Björnhaug G., (1981.) Separation and retrograde transport in the large intestine of herbivores. *Livest. Prod. Sci.*, 8, 351-360.

5. Cole C B, Scott K J, Henschel M J, Coates M E, Ford J E and Fuller R 1982. Trace nutrient binding proteins in milk and the growth of bacteria in the gut of infant rabbits. *British Journal of Nutrition* 49: 231-240.
6. Frylestam, B. (1986) Agricultural land use effects on the winter diet of brown hares (*Lepus europaeus* Pallas) in southern Sweden. *Mammal Review* 16: 157–161.
7. Garcia J., Carabano R., de Blas J.C., (1999.) Effect of fiber source on cell wall digestibility and rate of passage in rabbits. *J. Anim. Sci.* 77, 898–905
8. Homolka, M. (1985) Spatial activity of hares (*Lepus europaeus*). *Folia Zoologica* 34: 217–226.
9. Katona, K., Biro, Z., Szemethy, L., Demes, T., i Nyeste, M. (2010). Spatial, temporal and individual variability in the autumn diet of European hare (*Lepus europaeus*) in Hungary. *Acta zoologica academiae scientiarum Hungaricae*, 56(1), 89-101
10. Kovács, Gy. & Búza, Cs. (1988) A mezei nyúl (*Lepus europeus* Pallas) mozgáskörzetének jellemzői egy erdőstűlt és egy intenzíven művelt alföldi területen, novemberben. (Characteristics of the home range of the brown hare (*Lepus europeus* Pallas) in a forested and in a large-scale cultivated agricultural habitat. 1. Size of the home range.) *Vadbiológia* 2: 67–84. [in Hungarian with English summary]
11. Lord R. D., Jr 1959. Comparison of early morning and spotlight roadside censuses for cottontails. *J. Wildl. Manage.* 23: 458 - 460
12. Suchentrunk F, Willing F, Hartl GB, (1991.) On eye lens weights and other age criteria of the Brown hare (*Lepus europaeus* Pallas, 1778, *Z. Säugetierkd*, 56, 365-374.
13. Rieck W, (1962), Analyse von Feldhasenstrecken nach dem Gewicht der Augenlinse, Suppl. *Ricerche di Zoologia appl. alla Caccia*, Vol. IV, Bologna
14. Reichlin, T., Klansek, E. & Hackländer, K. (2006) Diet selection by hares (*Lepus europaeus*) in arable land and its implications for habitat management. *European Journal of Wildlife Research* 52: 109–118.
15. Stott P., (2008). Comparisons of digestive function between the European hare (*Lepus europaeus*) and the European rabbit (*Oryctolagus cuniculus*): mastication, gut passage and digestibility. *Mammalian biology*, 73, 276–286
16. Suchentrunk F, Willing F, Hartl GB, (1991), On eye lens weights and other age criteria of the Brown hare (*Lepus europaeus* Pallas, 1778, *Z. Säugetierkd*, 56, 365-374.
17. Šelmić V, (1984), Proučavanja zakonomernosti dinamike populacije zeca u Vojvodini i njihova primena u planiranju racionalnog korištenja, Disertacija, Šumarski fakultet Beograd, Srbija.
18. Šelmić V, Đaković, M Novkov, (1999), Istraživanja realnog prirasta zečijih populacija i mikropopulacija u Vojvodini, Godišnji izveštaj o naučnoistraživačkom radu u organiza

PHYLOGEOGRAPHIC POSITION OF BROWN HARES FROM VOJVODINA

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Summary: Previous phylogeographic analyses revealed presence of five different haplogroups in brown hares based on mtDNA variability: 'Anatolian/Middle East type haplogroup' (Turkey, Israel, north-eastern Greece, Bulgaria); 'south-eastern European type haplogroup' (Greece, Bulgaria, Croatia, Italy); 'European type haplogroup', divided into two subgroups: subgroup A (central Europe, the United Kingdom, Spain, France, Netherlands, Germany, Bulgaria) and subgroup B (Greece, Crete, Bulgaria); and 'intermediate haplogroup' (Greece, Bulgaria). The postglacial recolonization of central and northwestern continental Europe by the brown hare has started exclusively from the Balkans due to the lack of profound geographical barriers in south-north direction. The aim of this study was to determine phylogeographic position of the brown hare (*Lepus europaeus*) in Vojvodina (the Northern Province of Republic of Serbia) by analyses of control region mtDNA sequence variability. In total, 135 brown hares, sampled in a period 2004-2014, were analysed for mitochondrial DNA variation by sequence analysis of the control region (CR-I). The data were compared with mtDNA CR-I sequences retrieved from GenBank. Genetic diversity was determined using standard population-genetic softwares. Haplotype diversity was $H_d=0.915$ and nucleotide diversity $\pi=0.012$. Phylogeographic analysis revealed two main groups corresponding to 'Anatolian/Middle East type haplogroup' and 'European type haplogroup', while the second was divided into two subgroups, which corresponded to subgroups A and B. The majority of haplotypes found in brown hares from Vojvodina were grouped in 'European type haplogroup' subgroup A, while two were grouped in 'Anatolian/Middle East type haplogroup'. The presence of these haplotypes is expected in the south-eastern Balkans, and not in the north Balkans. It might be that translocations could be responsible for the presence of unexpected haplotypes in this area.

Key words: brown hare, Vojvodina, mtDNA

Introduction

The brown hare (*Lepus europaeus*, Pallas 1778) inhabits large area in Europe and represents one of the most important game species. Brown hare represents also very important game species in Serbia, particularly in Vojvodina Province, the northern part of the country. In the mid of 20th century, brown hare was the most numerous game species in Vojvodina (between 400000 and 500000 individuals). Human activities hardly influenced brown hare populations and population size was reduced to about 200000 hares within a decade (Vapa and Selmic, 1997). In 1971 the hare number decreased below 200000 and hunting was banned for two years. Similar regional population size decline was also registered in different parts of Europe (Suchentrunk et al. 2003), most probably reflecting intensive environmental changes.

Determination of genetic variability and structure and maintenance of genetic resources of locally adapted populations is considered important for the long-term development of brown hares (Hartl et al. 1993, Suchentrunk et al. 2003; Vapa et al. 2007; Djan et al. 2013). Usually, analyses of molecular diversity and structure are primarily devoted to small populations with high inbreeding effects and genetic drift (Frankham et al., 2010; Tammela et al., 2010). However, investigations of genetic variability in large and continuous populations are of extreme importance since intraspecific introgression may affect locally adapted populations (Frankham et al., 2010; Linnel and Zachos, 2011).

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First genetic studies of brown hare population from Vojvodina were performed by biochemical-genetic analyses and revealed a normal level of genetic variability for mammalian species (Vapa et al. 2002; Davidovic 2003; Vapa et al. 2007). Genetic variability of the hares from Vojvodina was within the range found for the central European populations (Vapa et al. 2007) as well as the southeastern Balkans populations (Suchentrunk et al. 2003). Also, a slight gene pool substructuring, indicating demic structure was found (Vapa et al. 2007). According to study on genetic variability of brown hares from Vojvodina based on large set of allozymes, population was grouped into Central European brown hare populations group (Davidovic 2003). Furthermore, the analysis of mtDNA variability in brown hares from Vojvodina adjoined them to the Central European brown hare haplotypes group (Djan et al. 2006). Microsatellite data from the same population proved moderate level of genetic variability and substructuring of the population (Djan et al. 2008; Djan et al. 2012).

Previous phylogeographic analyses of brown hares revealed presence of five different haplogroups based on mtDNA variability: 'Anatolian/Middle East type haplogroup' (Turkey, Israel, north-eastern Greece, Bulgaria); 'south-eastern European type haplogroup' (Greece, Bulgaria, Croatia, Italy); 'European type haplogroup', divided into two subgroups: subgroup A (central Europe, the United Kingdom, Spain, France, Netherlands, Germany, Bulgaria) and subgroup B (Greece, Crete, Bulgaria); and 'intermediate haplogroup' (Greece, Bulgaria) (Stamatis et al. 2009). Study performed by Stamatis et al. (2009) grouped all individual sequences from Vojvodina into 'European type haplogroup' subgroup A. The postglacial recolonization of central and northwestern continental Europe by the brown hare has started exclusively from the Balkans due to the lack of profound geographical barriers in south-north direction (Kasapidis et al. 2005; Stamatis et al. 2009). Thus, Vojvodina represents the most northern part of the presumed glacial refugium and the territory which represents main postglacial expansion route in Europe.

The aim of this study was to determine phylogeographic position of the brown hare (*Lepus europaeus*) in Vojvodina (the Northern Province of Republic of Serbia) by analyses of control region mtDNA sequence variability.

Material and Methods

In total, 135 brown hares, sampled in a period 2004-2014, were analysed for mitochondrial DNA variation by sequence analysis of the control region (CR-I). All brown hare samples were collected during legal hunt periods and muscle tissue samples were frozen until the laboratory analyses.

Total DNA was extracted using standard phenol chloroform isoamylalcohol extraction with proteinase K digestion (Kocher et al. 1989).

Amplification of the mtDNA control region, hypervariable domain 1 (CR-1), was carried out using modified method of Kasapidis et al. (2005). Following primers were used for the amplification: forward 5'AAGAACCAGATGCCAGTTATAG3 and reverse 5'AATTCTCTTTAACTATTCTCTGC3. The PCR reactions were performed using a Mastercycler Personal thermocycler (Eppendorf, Hamburg, Germany). Approximately 100 ng of genomic DNA was used as a template with 0.5 µM of each primer, 0.2 mM dNTPs, 1.5 mM Mg (OAc₂), 1x Taq Buffer (15mM Mg(OAc₂)) and 0.5U Taq polymerase (Fermentas, Vilnius, Lithuania) in a total volume of 25 µL. The initial denaturation was set at 95 ° C for 5 minutes, followed by 35 cycles with a denaturation step (94 ° C for 1 minute), annealing (45 seconds at 50 ° C) and elongation (45 seconds at 72 ° C) and a final extension at 72 ° C for 5 minutes.

Successfully amplified PCR products were purified prior to sequencing using a commercial kit ExoI-SAP (Fermentas, Vilnius, Lithuania) according to the manufacturer's instructions. The sequencing of the CR-1 mtDNA was done at the Institute for Molecular Medicine Finland on a capillary sequencer ABI 3730XL DNA Analyzer (Applied Biosystems, Foster City, CA, USA) using BigDyeTerminator v3.1 Cycle Sequencing kit (Life Technologies, Carlsbad, CA, USA). Sequencing was carried out using forward primers. The quality of each sequence was evaluated by eye using program BioEdit (Hall, 1999)

The initial step in the analysis was sequence alignment performed using the Clustal W algorithm (Thompson et al. 1994) integrated within the software package BioEdit v7.0.5.3 (Hall 1999). First data set consisted of 135 CR-1 mtDNA sequences with total length of 358bp. Sequences from the first data set were combined with sequences retrieved from GenBank (Kasapidis et al. 2005, Sert et al. 2009; Stamatis et al. 2009) and formed second dataset of 348 sequences (final length 358bp).

The parameters of molecular diversity, the number of haplotypes (h) and the haplotype diversity (Hd), nucleotide diversity (π), and the average number of nucleotide differences (k) were determined using the software package DnaSP v.5.10.01 (Librado and Rosas, 2009). Median-joining, with the aim of determining phylogeographic structure and defining haplogroups, was constructed by the algorithm described by Bandelt et al. (1999) the software package within the Network 4.6.1.2. (Fluxus Technology Ltd., Sudbury, England). As indicators of demographic expansion tests of selective neutrality: Tajima D test (Tajima 1989) and Fu's Fs test (Fu, 1997) were performed in DnaSP.

Results and Discussion

Analysis of CR-1 mtDNA sequences variability in brown hares from Vojvodina revealed presence of 37 different haplotypes. Haplotype diversity was Hd=0.915 and nucleotide diversity π =0.012 (Tab. 1).

Table 1. Molecular diversity indices in brown hare population from Vojvodina based on CR-1 mtDNA sequence variability

	Vojvodina
Number of samples	135
Number of haplotypes	37
Haplotype diversity	0.915
Nucleotide diversity	0.012
Pairwise differences	4.457
Fs (p)	4.267 (0.290)
D (p)	1.342 (0.026)

Results of this study showed high haplotype and nucleotide diversity. Previous studies of variability CR-1 mtDNA in *L. europaeus* showed that contrary to the relatively low nuclear gene pool divergence observed on the large geographic scale, mtDNA differentiation is much higher between populations from the Balkans and central Europe (Mamuris et al. 2001; Kasapidis et al. 2005; Ben Slimen et al. 2005, 2006; Fickel et al. 2005, 2008). The highest values of haplotype and nucleotide diversity indices were found in brown hare populations from Greece (Mamuris et al. 2001; Stamatis et al. 2009) and those values were decreasing in south-north direction. Brown hare population from Vojvodina showed haplotype diversity value similar to brown hare populations from Central Europe (Stamatis et al. 2009). Neutrality tests results showed that brown hare population from Vojvodina express a recent expansion signal, although obtained indices values were not significant (Tab. 1).

The second dataset in this study was used for the phylogeographic analysis and construction of Median-joining network. Due to the complexity of obtained network and large number of haplotypes, just schematic main haplogroups are presented (Fig. 1). Phylogeographic analysis revealed two main groups corresponding to 'Anatolian/Middle East type haplogroup' and 'European type haplogroup', while the second was divided into two subgroups, which corresponded to subgroups A and B (Stamatis et al. 2009). The majority of haplotypes found in brown hares from Vojvodina were grouped in 'European type haplogroup' subgroup A, while two were grouped in 'Anatolian/Middle East type haplogroup'. The presence of these haplotypes is expected in the south-eastern Balkans, and not in the north Balkans. It might be that translocations could be responsible for the presence of unexpected haplotypes in this area.

The position of haplotypes found in brown hare from Vojvodina in the network support the earlier phylogeographic model suggested by Stamatis et al. (2009), and furthermore suggests that hares from the northern Balkans are all originating from the central Balkans and populations from central and northwestern Europe are all originating from the north Balkans.

The structure of 'European type haplogroup', subgroup A fully supports the hypothesis of the important role of the Balkans as a major refugium in postglacial colonization of Europe, due to the lack of large geographic barriers to the north (Stamatis et al., 2009). The most frequent haplotypes of this group

are directly connected to haplotypes from Vojvodina, and the samples from Vojvodina also have the most frequent haplotypes in this haplogroup.

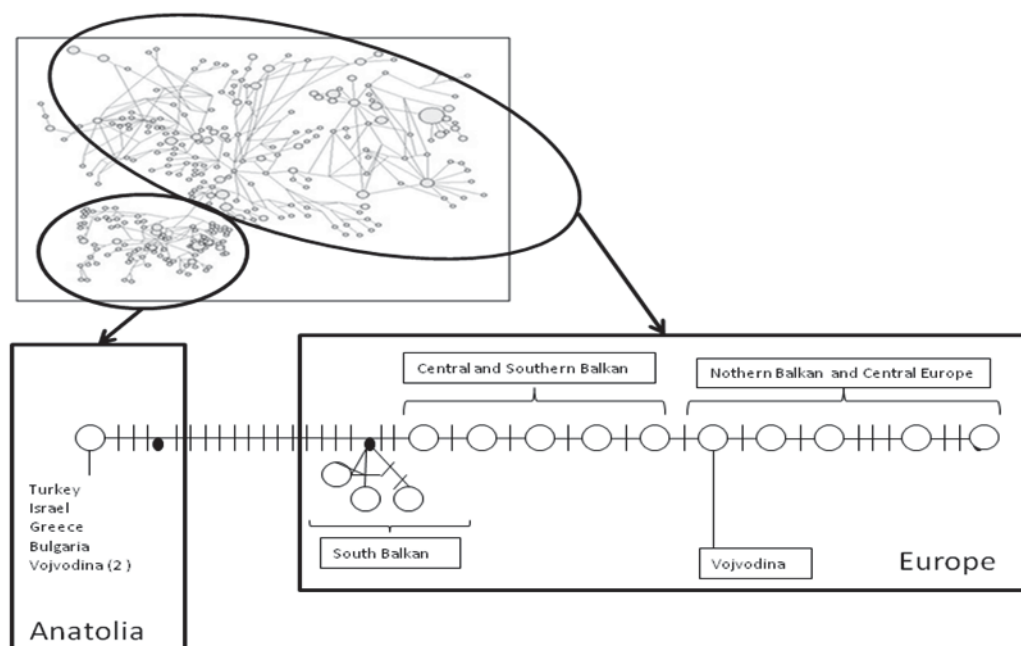


Figure 1. Median joining network of CR-1 mtDNA haplotypes in *Lepus europaeus* from Anatolia and Europe. The main torso of the network is schematically presented. Dashes show the number of mutational steps.

Conclusion

The molecular diversity of CR-1 mtDNA sequences of brown hare population from Vojvodina Province showed that selected molecular marker is adequate for the analysis of molecular diversity and phylogeographic position of sampled population. Phylogeographic pattern shows south-north gradient and two major haplogroups, Anatolian and European, are defined. As in earlier phylogeographic model proposed by Stamatis et al (2009), European haplogroup is structured to Balkan and Central European subgroups. All haplotypes from Vojvodina were grouped in Central European subgroup, except two detected haplotypes, which were grouped in Anatolian subgroup. The latest indicate presence of past possible translocations in the area. Nevertheless, analysed population preserved high genetic diversity. Particular attention should be paid to the regulated translocations of individuals, with the aim to preserve local genetic variability.

Acknowledgment

This work was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Grant No. 43002 and the Provincial Secretariat for Science and Technological Development, Grant No. 114-457-2173/2011-01 and Provincial Secretariat for Agriculture, Water Management and Forestry Project „Biomonitoring of local brown hare populations (*Lepus europaeus* Pallas) in Vojvodina based on heavy metal accumulation in target tissues”.

References

1. Bandelt, H-J., Forster, P., Roohl, A. (1999) Median-Joining Networks for Inferring Intraspecific Phylogenies. *Molecular Biology and Evolution*, 16(1): 37–48.

2. Ben Slimen, H., Suchentrunk, F., Memmi, A., Sert, H., Kryger, U., Alves, P. C., Ben Ammar Elgaaied, A. (2006) Evolutionary relationships among hares from North Africa (*Lepus* sp. or *Lepus* spp.), cape hares (*L. capensis*) from South Africa, and brown hares (*L. europaeus*), as inferred from mtDNA PCR-RFLP and allozyme data. *J. Zool. Syst. Evol. Syst.* 44: 88–99.
3. Ben Slimen, H., Suchentrunk, F., Memmi, A., Ben Ammar Elgaaied, A. (2005): Biochemical genetic relationships among Tunisian hares (*Lepus* sp.), South African Cape hares (*Lepus capensis*), and European brown hares (*L. europaeus*). *Biochem. Genet.* 43: 577–596.
4. Davidović M. (2003) Molekularno genetička analiza varijabilnosti populacije zeca (*Lepus europaeus*, Pallas) u Vojvodini. Magistarski rad, Biološki fakultet, Beograd
5. Djan M., Veličković N., Popović D., Obreht D., Beuković M., Vapa Lj. (2012) Genetic monitoring of populargame species in hunting areas of Vojvodina. International symposium on hunting „Modern aspects of sustainable management of game population“, Zemun-Belgrade, Serbia, 22.-24. June, 2012, 79-82.
6. Djan, M. (2008) Polimorfnost mikrosatelita i mtDNK u populacijama zeca (*Lepus europaeus*, Pallas). Doktorska disertacija. Prirodno-matematički fakultet, Novi Sad.
7. Djan, M., Obreht, D., Vapa, Lj. (2006) Polymorphism of mtDNA regions in brown hare (*Lepus europaeus*) populations from Vojvodina (Serbia and Montenegro). *European Journal of Wildlife Research*, 52: 288-291.
8. Djan, M., Veličković, N., Obreht, D., Stefanović, M., Beuković, D., Beuković, M. (2013) Brown hares in hunting areas of Vojvodina: genetic diversity as revealed by mtDNA sequences. *Proceedings of the 2nd international Symposium on Hunting “Modern aspects of sustainable management of game populations”* Novi Sad, Serbia, 17-20. October, 2013. 191-196.
9. Fickel, J., Hauffe, H.C., Pecchioli, E., Soriguer, R., Vapa, Lj., Pitra, C. (2008) Cladogenesis of the European brown hare (*Lepus europaeus* Pallas, 1778). *European Journal of Wildlife Research*, 54(3): 495-510.
10. Fickel, J., Schmidt, A., Putze, M., Spittler, H., Ludwig, A., Streich, W.J., Pitra, C. (2005) Genetic structure of populations of European brown hare: implications for management. *Journal of Wildlife Management*, 69: 760–771.
11. Frankham, R., Ballou, J., Briscoe, D. (2010) *Introduction to Conservation Genetics*, 2nd edn. Cambridge University Press, Cambridge, UK.
12. Fu, Y. (1997) Statistical tests of neutrality of mutations against population growth, hitch-hiking, and background selection. *Genetics*, 147: 915-925.
13. Hall T.A. (1999) BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series*, 41: 95-98.
14. Hartl, G. B., Suchentrunk, F., Nadlinger, K., Willing, R. (1993) An integrative analysis of genetic differentiation in the brown hare *Lepus europaeus* based on morphology, allozymes, and mitochondrial DNA. *Acta Theriol.* 38(Suppl. 2): 33–57.
15. Kasapidis, P., Suchentrunk, F., Magolas, A., Kotoulas, G. (2005) The shaping of mitochondrial DNA phylogeographic patterns of the brown hare (*Lepus europaeus*) under the combined influence of Late Pleistocene climatic fluctuations and anthropogenic translocations. *Molecular Phylogenetics and Evolution*, 34(1): 55-66.
16. Kocher, TD, Thomas, WK, Meyer, A (1989) Dynamics of mitochondrial DNA evolution in animals: amplification and sequencing with conserved primers. *Proc Natl Acad Sc USA* 6106–6200
17. Librado, P., Rozas, J. (2009) DnaSP v5: A software for comprehensive analysis of DNA polymorphism data. *Bioinformatics*, 25: 1451-1452.
18. Linnel, J., Zachos, F. (2011) Status and distribution patterns of European ungulates: genetics, population history and conservation. *Ungulate Management in Europe: Problems and Practices* (ed. by R. Putman, M. Apollonio & R. Andersen), pp. 12-53. Cambridge University Press, Cambridge, UK.
19. Mamuris, Z., Sfougaris, AI, Stamatis, C (2001) Genetic structure of Greek brown hare (*Lepus europaeus*) populations as revealed by mtDNA RFLP-PCR analysis implications for conserving genetic diversity. *Biol Conserv* 101:187–196
20. Sert, H., Ben Slimen, H., Erdogan, A., Suchentrunk, F. (2009) Mitochondrial HVI sequence variation in Anatolian hares (*Lepus europaeus* Pallas, 1778). *Mammalian Biology*, 74: 286-297.
21. Stamatis, C., Suchentrunk, F., Moutou, K.A., Giacometti, M., Haerer, G., Djan, M., Vapa, Lj., Vukovic, M., Tvrtkovic, N., Sert, H., Alves, P.C., Mamuris, Z. (2009) Phylogeography of the brown hare (*Lepus europaeus*) in Europe: a legacy of south-eastern Mediterranean refugia? *Journal of Biogeography*, 36(3): 515-528.
22. Suchentrunk, F., Mamuris, Z., Sfougaris, A. I, Stamatis, C. (2003) Biochemical genetic variability in brown hares (*Lepus europaeus*) from Greece. *Biochem. Genet.* 41: 127–140.
23. Tajima, F. (1989) Statistical method for testing the neutral mutation hypothesis by DNA polymorphism. *Genetics*, 123: 585–595.
24. Tammelaht, E., Remm, J., Korsten, M., Davison, J., Tumanov, I., Saveljev, A., Mannil, P., Kojola, I. Saarma, U. (2010) Genetic structure in large, continuous mammal populations: the example of brown bears in northwestern Asia. *Molecular Ecology*, 19: 5359-5370.
25. Thompson, J.D., Higgins D.G., Gibson T.J. (1994) CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research*, 22(22): 4673-4680.
26. Vapa, L., Djan, M., Obreht, D., Hammer, S., Suchentrunk, F. (2007) Allozyme variability of brown hares (*lepus europaeus*) from the Vojvodina (Serbia), compared to central and southeastern European populations. *Acta Zoologica Academiae Scientiarum Hungaricae* 53 (1): 75–87.
27. Vapa, Lj., Obreht, D., Vapa, M., Šelmić, V. (2002) Genetic variability in brown hare (*Lepus europaeus*) populations in Yugoslavia. *Z. Jagdwissenschaft*, 48: 261–266
28. Vapa, M., Selmic, V. (1997) Presence and future of brown hare. Pp. 33–45. *In: Selmic, V. (ed): Proceedings of the Hunting Symposium “Brown hare and patridge in modern agroecosystems”*. Novi Sad, Hunting Society of Vojvodina.

DRAFTING THE BIOSECURITY MEASURES IN PHEASANTS RAISING TECHNOLOGY

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Summary: One of the key factors for successful farm production of pheasants game is to maintain constant biosecurity measures through all the phases of production technological procedure. Key biosecurity measures that should be constantly maintained in farm facilities are disinfection and pest control. The paper describes disinfection and pest control procedures and the effects thereof that served as a basis for drafting the biosecurity protocol. Besides these measures biosecurity protocol was based observing also the construction and technical characteristics of pheasant farm, i.e. farm production units and farmyard, and an applied production technological process. The mentioned research in a previous period was conducted on pheasant farm "Rit" in Padinska Skela, near Belgrade.

Key words: pheasant farm, biosecurity measures, biosecurity protocol, disinfection, pest control

Introduction

An increase in production of pheasants game was brought about by an increased interest of hunters in shooting range hunting and the attraction of pheasants hunting in open hunting grounds. One of important arguments for increased production of pheasant game is the need to preserve optimal number of population in the nature. Despite the fact that pheasant is the most abundant and productive species of poultry game, the attempts made by a number of individuals and hunting organisations to conduct an intensive breeding of pheasants in various facilities by using different technological procedures often ended up by mass deaths and economical disaster. In order that production should be successful and economically justified, i.e. in order to obtain satisfying number of healthy individuals in good shape, it is necessary to fulfill three following conditions: firstly, to possess facilities of satisfying construction and technical characteristics, secondly, to use adequate production technology with suitable equipment, and thirdly, considered as key condition which directly affects health status of individuals, to apply constant biosecurity measures according to previously defined biosecurity protocol, for each facility separately (Anon, 2012; Đorđević 2009, 2012, 2013)

Pheasants farms are types of semi-closed production facilities consisting of several production units cyclically connected where the birds of various age categories are raised. Following production units are involved in technological chain and they are: aviary for breeding stock, eggs store-room, incubator station, rooms for young pheasants raising and aviary with poultry runs where the pheasants are raised until released into hunting ground. Production technological procedure characterised by breeding the birds of different age categories within single farmyard represents a serious health risk and as such requires continual application of biosecurity measures with constant control of health status of individuals in different production phases (Pavlović, 2004, Đorđević, 2009, 2012).

This paper defines disinfection and pest control as two key biosecurity measures of biosecurity protocol.

The place and role of disinfection in biosecurity protocol

Besides routine maintenance of hygiene of farm facilities and equipment a great importance is attached to disinfection since it represents one of the key ways to reduce the number of microorganisms

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which can often be detected on various surfaces within production units on pheasant farm (Ilić et al., 2008; Matković, 2006; Đorđević, 2013). For the purpose of disinfection of farm buildings in various phases of production we use various disinfectants that produce bacterial, fungicidal and viral effects by help of different techniques. Considering the fact that the criteria for the choice of disinfectant which will be used for the treatment is its widest possible range of performance in smallest possible concentrations, excluding negative effects on surfaces, equipment, and people, animals and environment, one of the key moments for the choice of disinfectant is the price as well. By the analysis of the situation on the terrain it can be observed that the most used disinfectants are those belonging to following chemical groups: formaldehyde, chloride, iodine, phenol, quaternary amonium compounds, cresol and peracetic acid. In our trial in different production stages we monitored the effects of two disinfectants based on the peracetic acid, the preparation called Peral-S, and on formaldehyde, preparation called Formalin. We must bear in mind that microorganisms in time become resistant and that uncontrolled use of disinfectants may lead to resistance which can be hard to control. For this reason it is necessary to continuously conduct disinfection as preventive health measure on one hand and constantly monitor the effects of conducted disinfection respecting the rules on concentration of working solutions and the length of application of chemical compounds in the facilities on the other. Disinfectant effects assessment is most often done by taking swabs from treated surfaces (floors, walls, equipment) before and after disinfection. It is certain that the success of disinfection in different production units depends on preparation, primarily from the aspect of removing visible and invisible dirt of organic and inorganic origin by mechanical and sanitary cleaning.

The experience gained on pheasant farm “Rit“ in Padinska Skela

Analysing the results obtained by microbiological examinations before and after disinfection conducted in the course of research on certain surfaces of production units we observed that applied disinfectants made on the basis of peracetic acid solution and formalin vapour have showed satisfying effects on the surfaces of walls, floors, feeder parts, water troughs, litters, earth-floored aviaries, interior of incubators and hatcheries. The 2 % solutions of disinfectants based on peracetic acid applied by sprinkling the surfaces and dipping some equipment showed satisfying results on the surfaces and equipment previously thoroughly mechanically cleaned and washed while the for surfaces such as wooden feeders, not possible to be adequately mechanically cleaned and washed, the results of disinfection by application of the peracetic acid solution were not satisfying. The results obtained after disinfection of aviary soil surfaces by application of 3% peracetic acid solution were satisfactory. Besides the problem with wooden feeders the presence of microorganisms was detected on egg cartons on which even the treatment with formalin vapour obtained no satisfying results. The use of formalin vapour showed satisfying results after previous mechanical cleaning and sanitation of the incubator and hatchery.

Proposals for measures and procedures to be identified in biosecurity protocol regarding disinfection

- After completion and before the start of new production cycle all buildings – the interior of production facilities and equipment (unit with aviary for breeding stock, eggs store-room, incubator station, rooms for young pheasants and unit for keeping pheasants until they are released into hunting ground) must be mechanically cleaned by use of standard kit (brooms, brushes, etc.) of all dirt and thoroughly washed by warm water (water temperature up to 56°C).
- Upon mechanical cleaning and sanitary washing and drying the walls and ceilings of all production units must be whitewashed.

- The floors of all production units that have been cleaned, washed, dried, and cracks repaired, must be treated – sprinkled by motor sprinkler with 2% water dissolved disinfectant based on peracetic acid or some other disinfectant with well-known effect.
- Equipment (feeders, watering troughs, batteries, egg cassettes) should, if possible, be made of non-corrosive materials, preferably of plastic or inox, with flat surfaces and disinfected by dipping after being washed in 2% disinfectant water solution based on peracetic acid or some other disinfectant with well-known effect.
- Soil surfaces in aviaries should be re-plowed or cultivated, treated by lime powder. Our practise was to cultivate soil surfaces and several days later to monitor the effects of treatment by 3% disinfectant water solution based on peracetic acid applied by motor sprinkler. Obtained results were satisfactory.
- Incubators and hatcheries should, after thorough cleaning and washing, be disinfected by formalin vapour (for 1 m³ we used 60 ml formaldehyde and 40 gr hypermanganese).
- Carton boxes for eggs transport and storage and the straw used as litter should be disinfected by formalin vapour. The straw should be treated by formalin vapour before being brought into production units for breeding stock and room for raising pheasants 2-6 weeks old, as well as in other facilities according to production technology. Formalin vapours must act for 30 minutes, upon which time the rooms, incubators, hatcheries and store-room for egg cartons and rooms where straw fumigation was carried out should be well ventilated. The disinfection by formalin vapour must be done by professional persons with all measures of precaution and personal safety taken and observed.

Controlling the effects of disinfection and surfaces microbiological status in production units on pheasant farm

- It is necessary to check microbiological status of the surfaces inside production units, equipment surfaces (feeders, watering troughs, egg cassettes, batteries), store-rooms for eggs and cartons, interior of incubators and hatcheries, soil surfaces in aviaries and litter by taking swabs before and after disinfection in defined time periods. Facilities and equipment surface swabs are taken by commercial sterile swabs dipped in sterile physiological solution by means of plastic pattern (10x10cm) always from the same surface inside facility before and 30 minutes after disinfection. Aviary soil surface swabs are taken by boots covers put on by vets on entering the aviary and taken off when going out. Besides taking samples by boots covers we must take samples of the aviary soil at various sites at the depth of 5cm by random selection method in order to detect anaerobes.
- In order to properly check the microbiological status of production units inside pheasantry breeding house it is necessary to follow certain dynamics. The first check of microbiological status of production unit in which breeding stock is placed should be done before the hatching of eggs. By the random sample method we take five swabs of each surface portion of feeders, water troughs, walls and floor of the facility for breeding stock, and soil in aviary by use of boot covers according to previously defined procedure.
- Before and after fumigation it is necessary to take five samples of straw by the random choice method in order to check its bacteriological and mycological status. In the next period according

to production dynamics we must take swabs to check microbiological status of the surfaces in following production units: eggs store-room where by the method of random choice we take five swabs each of the floor and wall surface inside the facility and five swabs of egg cassettes and cartons. In incubator station by the method of random choice we must take five swabs each of the surfaces of walls and floor of incubator room and five swabs of the interior of every incubator and egg cassettes. In the hatchery by the method of random choice we must take five swabs of the surfaces of walls and floor and five swabs of the interior of every egg incubator, as well as five swabs each of the egg cassettes inside each hatchery.

- In the pheasants breeding unit up to the second week of birds age by the method of random choice it is necessary to take five swabs of the surfaces of walls and floor as well as of the empty batteries surfaces. In the facilities for pheasants raising from the second up to the sixth weeks of age and in the facilities for 6 weeks old pheasants by the method of random choice it is necessary to take five swabs of the surfaces of walls, feeders and water troughs, and soil in aviary by boots covers according to previously defined procedure.
- Upon properly taken swabs according to previously defined procedure and dynamics the swabs are placed into portable fridge and transported to laboratory. In lab conditions we determine bacteria count, examine culture properties and detect enterobacteria, Salmonella, anaerobes, fungi and mould.

The place and role of pest control as biosafety measure in biosecurity protocol

Pheasant breeding house as a facility for intensive pheasant breeding with its auxilliary structures and surrounding farmyard is regularly envaded by smaller of larger population of mouse-like rodents, especially house mouse and black and grey rats. In the farmyard around pheasant breeding house and other facilities we can find population of field mouse and underground and field vole. Presence of mouse-like rodents population in certain production units and auxilliary facilities represents a great epidemiological and epizootiological as well as economic risk. Every day their numerous population destroys huge quantities of food by eating it, damaging and polluting. All these impose a need for constant control over their number and for taking some measures to regulate their population. In pheasant breeding houses depending on their hygienic and sanitary state and construction and production units technical characteristics the mouse-like rodents can be most often found in aviaries for breeding stock and young pheasants raising, then in incubator stations and units for pheasants raising, in the holes under the floors, in lower thirds of walls and in the loft space. Mouse-like rodents often inhabit the holes close to the farm facilities, auxilliary rooms and other parts of farm yard as well as the zone of manure storage and other kinds of waste. Mouse-like rodents enter the facilities through the windows, doors, ventilation holes, sewage system and other holes made by mouse-like rodents due to bad type and quality of construction material, as well as to disrespecting the preventive construction standards in buildings construction. Easily accessible food, water, enough suitable places for forming the shelter enable the abundance of rodents to progressively increase even up to 10,000 during the annual production cycle. Rodents consume food, damage insulation, underdig the foundations and destroy the facilities structure. Each mouse consumes about 5.5 grams, rat even about 25.0 grams of food daily while about ten times more food they scatter and pollute what with previously mentioned number and number of days of one production cycle per year represents a huge quantity and serious economic loss. For that reason the regulation of the rodent population in pheasant breeding houses is payed a great attention to (NFBM, 2009; Judy Loven, Ralph Williams, 2010; Đorđević, 2012).

The assessment of number of mouse-like rodents in the buildings as defined by biosecurity protocol

- The assessment of the rodents number by the visual method is the method performed by the farmers employed on the pheasant farm. The aim of this method is to monitor potential presence

of rodents, in different periods during the day, so called day-night monitoring, detection of the faeces of mouse-like rodents as well as the presence of active holes in production units, around the buildings and in farmyard and surroundings. When the animals are not seen but the damages are visible, we can assess that there are about 1-100 rodents. If the animals are seen from time to time in late evening hours or at night the assessment is in the range of 100 to 500. If the animals are seen at night regularly and sometimes during the day the assessed number is 500 to 1000 individuals. If we see a great number of animals at night and some animals during the day on a regular basis we can speak about a high level of invasion of the building by mouse-like rodents and their number is assessed in the range of 1000 to 5000. Visual assessment of the number of rodents has its shortages but it is extremely important from the aspect of biosecurity and assessment of the results of pest control carried out by competent services.

- Indexing of rodents is the method used to monitor the number of rodent population in many farm buildings so it can be used for pheasant breeding houses as well. By this method the number of rodents is estimated as low, elevated and high by the marks from one to three. Complete program of indexing is led by written records in separate forms. At the beginning of indexing the form for visual assessment of the number of rodents is filled in by means of special technological procedure. On the basis of the records obtained by visual assessment of the number the mouse traps – boxes are placed on the sites where the rodents will most certainly be captured. Depending on the size and number of boxes in the production unit about 12 mouse-traps with 30 grams of food in each are placed for a week. Twice a week the mouse traps are checked. Every mouse trap in which the mouse was not caught is shifted to another place after first control. The programme of the control of number envisages humane euthanasia for caught rodents. Critical limit of the population number control is a minimum number $RI=1$. If the RI is higher than 1 the control programme should be repeated. Indexing is performed once a month in each production unit. All obtained results are always entered into a specially prepared patterns. During the procedure of the control of rodent population in pheasant breeding houses one person must always be employed to continuously monitor the number of population by the indexing method and on the basis thereof a specialised organisation will undertake the methods of regulation of rodent population.
- By the method of humane catching of the rodents in specially designed mouse-traps. By this method the assessment of the quality of programme of protection of buildings is conducted and measures of pest control carried out. In addition, respecting the fact that the mouse-like rodents are vectors of many diseases by a potential detection of certain pathogenes causative agents we assess the health risks for pheasant population inhabited in certain production units.

Farm facilities protection measures against the activity of mouse-like rodents defined by biosecurity protocol

- Pheasant breeding houses should regularly be kept clean and farmyard kept in order by regular cutting, disposal of shrubs and garbage in order to create unfavourable conditions for forming the habitats for rodents and their nutrition;
- Farmyard fencing foundations made at the depth of 50 cm, digging protective ditches;
- Making the sidewalks surfaces around the buildings 1-1.5 meters wide and about 0.15 meters deep;
- Placing protective nets on the windows and ventilation holes;
- Protection against rodents coming in through doors and other openings by placing automatic devices for closing the doors;
- Immediately upon detection all cavities and active holes should be sealed by various adequate materials (mixture of concrete and broken glass) ;
- Interior of the buildings must be maintained at a high level of hygiene meaning removing of all dirt or scattered food;
- Manure heaps near buildings are often the places in which rodents form their nests so in such case the manure heap should be completely removed;

- Proper manure storage at sufficient distance from the production units.

Chemical substances fighting the rodents

One of the very important and complex methods in utilisation of biosecurity measures of regulation of rodent population is the use of chemical rodenticides in various forms of baits. Baits can be in the form of powder, rolls, pellets, blocks, tablets and liquid. In the programmes of the control of number of population of mouse-like rodents by the use of chemical rodenticides the use of protection bait boxes of different formulations has been practiced. The boxes keep the bait clean and are a safe place for rodent feeding and they readily enter them. The boxes are designed in such a way that other animal species cannot reach rodenticide baits, primarily non-target animals. As the simplest solution for this type of boxes we can use plain plastic pipes 4cm/8cm wide and 30-45cm long.

Special boxes or previously mentioned auxiliary means containing chemical rodenticides are placed inside the rooms in which there is no possibility for the pheasant birds to come into contact with what means that in the production units where the individual birds are kept in floor litter system the boxes with rodenticides are not being placed. If there is a loft in the pheasant breeding house it is recommended to place the boxes with poisoned baits in the loft space and also in the parts of the rooms for food storage, eggs classification and storage observing special precaution measures aimed at preventing potential contamination of food and other raw material used in the pheasants feeding. Upon placing, the bait boxes are being checked every 2-4 days, and replenished by new quantities of baits depending on the consumption. In case the rats are problem, the boxes with larger entrance openings are placed on the sites of their activity with recommendation that the boxes should be placed near their potential nest and places of their higher activity.

During the baits placing and replenishing the use of gloves with a special vessel (little spoon) for adding the baits is obligatory. In the units in which the food and eggs are stored it is not recommended to use powder bait formulation. The powder can be very functional in the regulation of rodent population because it is most often placed during the route of movements of the rodents where it gets stuck onto their feet and hair but it is questionable from the aspect of potential contamination of equipment and feedstuffs near by. During the procedure of the regulation of rodent population fresh baits with quality and proper feeds must be used and the priority must be given to anticoagulant rodenticides. During the buildings cleaning the placing of baits is common because when there is no manure in which they like to hide the rodents gladly visit the boxes and consume poisoned baits. Besides anticoagulants we can also use fast acting rodenticides with all measures of precaution taken by specialists.

Regardless of the chemical compound and formulation every rodenticide should be:

- Toxic for mouse-like rodents in as smallest concentrations possible,
- Attractive bait trap preparation for mouse-like rodents,
- Death of rodents should be similar to natural death as much as possible,
- Harmless to people and useful animals in concentrations that are lethal to mouse-like rodents,
- Bait physical and chemical properties should not be repellent to rodents,
- Not provoke resistance in treated rodent populations,
- Should be used in such a form and manner so as to ensure successful eradication of rodents and protection from secondary intoxications, pollution of food and environment in general, and
- Cost of production and price of product available to end users.

According to the speed of effects that display the rodenticides are divided into fast-action-acute and slow acting -anticoagulants.

Acute rodenticides are fairly rarely used in pest control of farm buildings and their use requires special know-how and measures of precaution. These rodenticides have lethal effect on mouse-like rodents in a few minutes to up to twenty-four hours upon consumption, but they also display a fairly high repellent effect especially in rats taking into account their instinct to be suspicious to new sources of food. One of the problems of the use of fast poisons is the poisoning of non-target organisms, i.e. useful animals which can be often found in some production units or farmyard and may come in contact with rodenticide baits or corpses of poisoned mouse-like rodents. Because of that during the process of pest control by use of acute poisons there is a detailed plan of pest control, poisoned baits are most often

placed on a 24 hour basis and if necessary every three days with daily monitoring of specialists. Acute rodenticides provoke fast deaths what creates a great problem in treating the poisoned by these substances since there is no enough time for the use of antidotes. The group of acute – fast acting rodenticides include: zinc-phosphid, sodium-fluorineacetate, fluorine-acetamid, crimidine, barium-carbonate, strychnine, thallium-sulphate, brometalin, calciferol and norbormid. Today a serious problem is the uncontrolled use of zinc phosphid in open surfaces and in the buildings by the owners of the farm creating the conditions for mass poisoning of useful animals.

Nowadays the most commonly used pest control of farm buildings are slow-acting anticoagulant rodenticides. In pheasant farms pest control they are used in the form of solid and liquid poisoning baits or sprinkling powders. Unlike fast poisons the anticoagulant rodenticides does not provoke fear in rodents i.e. repelling effect, and are much safer for use from the aspect of undesired poisoning of useful animals. The reaction of these chemical preparations is based on preventing the blood coagulation, provoking rupture of blood vessels and incidence of haemorrhage in some organs and consequent death of animals due to bleeding.

Anticoagulant rodenticides are divided into anticoagulants of first and second generation. They display the effects in a few days which is their feature in common and differ in the number of consumptions needed to produce effect. Anticoagulanats of first generation must be consumed several times while one consumption of anticoagulants of second generation is enough to have acidic effect displayed. The anticoagulants of first generation include warfarin, chlorophacinone, diphacinone, pindin, coumachlor, coumatetralyl, coumafuryl, while the anticoagulants of second generation include bromadiolone, brodifacoum, defineacoum, difetialon, flocoumaphen.

The experience gained on pheasant farm “Rit“ in Padinska Skela

During examination made on pheasant farm we monitored a population of mouse-like rodents in production units and farm yard. In cooperation with the farmers on pheasant farm we did a visual assessment of the number of mouse-like rodent population. By visual assessment we observed a rather numerous population of mouse-like rodents on the pheasant farm in the range of 100 to 1000 animals. In the aviaries for breeding flock, feeds store-room and in the zone of manure storage the population of mouse-like rodents was observed regularly at night and sometimes during the day while in the other parts of production units the population of rodents was observed in late evening hours and sometimes at night. During monitoring we also observed the presence of faeces in all production units and detected many active holes in the store-room for feeds, eggs, in incubator station, about the foundations of the structure and in the unit for young pheasants breeding, as well as in the zone around aviaries and manure storage. The farmyard surrounding is in disorder with abundant vegetation. Farmyard is not enclosed and there are no physical barriers for rodents. On the basis of visual assessment it can be said in general that on the pheasant farm we detected a great number of grey and black rats, as well as house mouse and that the pheasant farm production units are not sufficiently protected against rodents.

Besides visual assessment of the number of the rodent population this number was also assessed by the method of indexing. Specialized mouse-traps with 30grams of bait were placed in three zones in four boxes and we monitored consumption every day until the seventh day. At the start of the trial in all zones of protection where the baits boxes were placed we recorded a high index of rodents (IR=3).

Upon visual assessment of the population number, the assessment of the number by the method of indexing in the first three days and the analysis of the state of farm yard and buildings in the pheasant farm yard, we took the measures to protect the structures by closing the holes in foundations, floors and walls by the mixture of concrete and broken glass. Sidewalks around the buildings were repaired, the nets placed on the windows and ventilation holes of the feeds store-room, store-room for eggs, incubator station and the unit for young pheasants raising. Besides the units physical protection measure we made our task to put the farmyard in order by cutting the grass, cleaning and moving the manure and garbage 50m away. Upon completed physical protection of the buildings and the assessment of the rodents number according to previously defined methods we placed special boxes with rodenticide preparations. Boxes were placed in three zones. The first zone of protection was placed at the edge of farmyard. The second zone of protection was placed around the buildings and in the zone of manure heap and the third zone of protection involved the placing of boxes with rodenticide baits inside the buildings, namely, in

the store-room for feeds, eggs, incubator station and in the aviary where young pheasants are raised in special batteries. Boxes with rodenticide baits inside the production units and around the units in the first zone of protection were placed in such a way to completely exclude the contact of useful animals with rodenticide baits. For the purpose of rodents eradication we used the baits based on bromadiolon, with 0.005% active matter, wherein in the interior space of the rooms we used pellets formulated baits while in the first and second zone of protection we used paraffin blocks. Upon placing the baits we monitored the consumption thereof on the third and seventh day. In the first zone of protection, and in the zone of manure heap, around aviary with breeding stock increased consumption of baits was observed as early as on the third day. After we assessed the quantity of consumed baits the boxes observed to have increased consumption were being replenished on a dialy basis by new quantities of bait. On the seventh day in the interior of the building the farmers observed the corpses of dead rodents in the feeds store-room, store-room for eggs and incubator station. Besides the visual assessment of the number of animals we assessed the number of the rodent population by the so-called method of indexing. On the seventh day after placing the baits in the first zone of protection and in the zone around manure heap and around great aviary with breeding stock we assessed the increased index of rodents (IR=2), while on the seventh day in other production units we recorded a low level of rodent index (IR=1).

Monitoring of the effects of pest control via assessment of number of rodents by the method of indexing was done 30 days after the baits had been placed when in the first zone of protection towards the part of farmyard stretching out into the woods and grown by vegetation a high index of rodents (IR=3) was recorded, in the second zone of protection around aviaries with breeding stock and manure heap the recorded index was IR=2, while in the other parts we recorded IR=1. After control, during a subsequent period, we monitored the bait consumption in all zones once in a week and added new quantities of bait where necessary.

Two months after placing the first quantity of baits in special boxes by visual assessment of number we observed a complete absence of rodents in production units. By the method of rodents indexing all zones of protection showed a low level of rodent index (IR=1) and it was confirmed that in the first and seconds zones of protection it is necessary to continuously control the consumption of baits in protective boxes and replenish them as appropriate.

By the research analysis it can in general be concluded that in the pheasant breeding houses as semi-closed buildings the forming of three zones of protection with placing rodenticide baits protective boxes is necessary and that by constant placing of baits and control of consumption of rodenticide in specialized boxes the number of population of mouse-like rodents can be reduced to biological minimum.

Conclusion

The owners of pheasant farms and pheasant breeding houses for the purpose of the production of vital individuals of good health status should, besides possessing adequate buildings for raising and know-how of pheasants production technology, devote special attention to constant utilisation of biosecurity measures in all production units on pheasant farm. One of the key moments for conducting biosecurity measures on pheasant farms is drafting the programme of disinfection and pest control adapted to facilities construction and technical characteristics and production technology. The paper presents the inputs for designing and utilisation of disinfection and pest control as biosecurity measures on pheasant farms. Respecting the fact that every pheasant farm has its specificities it is essential that the programmes of disinfection and pest control be made by specially registered organisations authorised for disinfection and pest control service, respecting the previously defined programme which is an integral part of biosecurity protocol and to keep written records on all measures undertaken.

Acknowledgements

The authors wish to thank the Ministry of Education, Science and Technological Development of the Republic of Serbia for funding this research paper within the Project TR-31009.

Literature

1. Annon, (2012), Biosecurity procedures in poultry production, OIE - Terrestrial Animal Health Code, Appendix 6.4.1., http://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/2010/en_chapitch_1.6.4.htm
2. Đorđević, M., (2009), Biosigurnosne mere u fazanerijama, Zbornik radova XIX savetovanje, Dezinfekcija, dezinsekcija i deratizacija u zaštiti životne sredine
3. Ilić Z., Jakic Dimic D., Pavlovic I., Zugic G., Gavrilovic M.,(2008), Efficacy of same antimicrobial substance at Salmonella microorganisms isolated in poultry breeding objects 1stMediterranean Summit of WPSA, Thessaloniki, Greece, 07-10
4. Matković K., Matković, S. , (2006), Važnost čišćenja i dezinfekcije u peradarstvu, Znanstveno stručni dio, Vol. VII, 95-99.
5. Pavlović, I., Floristean, I., (2004) Fazani - odgoj i zdravstvena zaštita (3), Biologija i fiziološke karakteristike (I). Živinarstvo, XXXIX(11), 12-13.
6. Đorđević M., Pavlović I. , Kulišić Z. ,(2012), Technological parameters and bio safety measures of artificially breed of pheasants, 1. Međunarodni simpozijum o lovstvu, » Savremeni aspekti održivog gazdovanja populacijama divljači« Beograd, Srbija, 22 – 24. jun.
7. Đorđević M. , Jevremović Jelena, Pešić B., Radanović O., (2013), Dezinfekcija kao biosigurnosna mera u fazaneriji, 2. Međunarodni simpozijum o lovstvu, » Savremeni aspekti održivog gazdovanja populacijama divljači« Novi Sad, Srbija, 17 – 20. oktobar.
8. Đorđević M., Radenković-Damnjanović Brana, Janković Ljiljana, Teodorović Radislava, Pešić B., (2012), Uloga i značaj sprovođenja deratizacije kao biosigurnosne mere u fazanerijama, XXIII savetovanje, dezinfekcija, dezinsekcija i deratizacija- jedan svet jedno zdravlje, sa međunarodnim učešćem, Fruška Gora, 24-27-maj.

RED DEER (*Cervus elaphus* L.) MANAGEMENT IN FRUŠKA GORA NATIONAL PARK (VOJVODINA)

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Summary: This paper presents the results of settlement and management of red deer in Fruška gora special-purpose hunting ground and National Park (Vojvodina) in submontane mixed broadleaf forests that were once part of its natural range. The total hunting ground area is 25,518 ha (105-539 m a.s.l.). In February 2009, red deer originating from Hungary (Kaposvár) were settled in the central area of the National Park in a place called Ravne (5♂ + 31♀), where an enclosed shelter area of about 100 ha had previously been established. The main goals of red deer settling in the area of Fruška Gora mountain were to establish a new viable free-ranging population which enables normal hunting management and ensure long-term economic benefit for the local community. The analysis is based on data from the planning documents of the PE "Fruška gora National Park", as well as on the basis of 70 discarded antlers measured according to the CIC formula and collected during a five year period (2010-2014). A total of three infrared sensor cameras (Dörr SnapShot / Mobil black 5.1) were placed at five locations from 1st December 2013 to 30th April 2014, and more than 10,000 JPEG images were saved. The results of measurement and analysis of discarded antlers indicate a high quality and good development of red deer males (2-6 years). A regular use of digital game cameras in several feeding sites enabled quick improvement of management and additional protection of the red deer. In addition, a number of other animal species which are important for hunting management were recorded – roe deer, wild boar, brown hare, fox and badger. In the spring of 2014, the estimated number of red deer in the open part of the hunting ground Fruška Gora National Park was about 100 specimens (45♂ + 55♀). According to the criteria for the assessment of reintroduction success, the settlement of red deer in the Fruška Gora National Park can so far be assessed as successful.

Key words: red deer, management, reintroduction, Vojvodina

Introduction

Red deer is a native species of our country characterized by great biological and economic values (Šelmić et al., 2001; Gačić, 2013). However, for several decades the state of the populations of this species has not been satisfactory and it is becoming truly worrying. The current number, (sex, age and trophy) structure and degree of use of red deer populations in most parts of Serbia, especially in the wild (so-called "open hunting grounds") are far below the potentials of natural forests and forest areas (about 2.5 million hectares or 30% of total area) (Gačić and Danilović, 2011; Gačić et al. 2012a, b). According to the official data (National Bureau of Statistics) the estimated number of red deer is the largest in the region of Vojvodina (about 3,100 specimens in the spring of 2011), while it is significantly lower in southern and eastern Serbia (about 950 specimens), especially in the Šumadija region and western Serbia (approximately 100 specimens). The registered red deer harvest in central Serbia, south of the Sava and Danube rivers amounts to 58 specimens, which is a small number compared to the estimated spring census of red deer (about 1,050 specimens).

In the past, red deer used to be a widespread and very abundant species in the hilly-mountainous areas south of the Sava and Danube rivers, but many of its populations were completely extinct due to excessive and uncontrolled hunting, competition with domestic livestock and the destruction or

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deterioration of habitats (Živančević 1956; Bojović, 1968). After World War II, red deer was reintroduced into several forest areas of central Serbia – Mali Jastrebac (1954), Deli Jovan (1960) and North and South Kučaj (1962). In recent years, the public enterprise “Srbijašume” conducted reintroduction of red deer in several new areas that were once part of its native range – Veliki Jastrebac and Sokolovica (1997), Cer (1998), Čemernik (2000) and Bukovik (2005). However, many of these reintroductions have not been performed in full accordance with the instructions drawn up by the IUCN / SSC (1998). For example, the conducted pre-project activities neither eliminated the causes of red deer decline nor secured long-term financial and political support (Gačić et al. 2005). In addition, red deer caused damage to forest flora in some fenced rearing centers (Gačić and Danilović, 2009).

There is a lot of data proving that in the past red deer used to live in the area of Mt. Fruška Gora (Marinović, 1930), but this population was completely extinct at the end of the 70-ies of the XX century. The reintroduction of red deer into this area was initiated after detailed biological considerations of a feasibility study (Ristić et al. 2011) and it was subsequently carried out in three phases: (1) the construction of the “Ravne” shelter; (2) the selection and settlement of the initial stock of red deer originating from Hungary; and (3) the monitoring of the newly-established population. The aim of this study was to analyze the reintroduction and management of red deer in the hunting ground Fruška Gora National Park.

Material and Methods

The study area was the special-purpose hunting ground and National Park Fruška Gora, located in the province of Vojvodina (Municipality of Irig, Sremska Mitrovica, Šid, Bačka Palanka, Beočin, Novi Sad and Sremski Karlovci). It is a lonely island mountain in the Pannonian Plain with a length of about 80 km and a width of about 13 km. The main characteristic of this national park is a number of endangered, rare and protected species of plants and animals, and its special value is 16 Orthodox monasteries. The climate is temperate continental with clearly distinguished cold and warm seasons. The mean annual temperature is 11.6°C (varying from 21.5°C in July to 0.3°C in January). The total hunting ground area is 25,518 ha (105-539 m a.s.l.), and the surface structure is dominated by forests and forest land (about 21,500 ha or 96%). The species raised in the open part of the hunting ground are red deer, wild boar and roe deer. The productive hunting area for red deer occupies 4,000 ha and belongs to the second quality class.

The analysis of past settlement and management of red deer was performed on the basis of data from planning documents and records of the PE “Fruška Gora National Park”, and their comparison with the works and measures planned in the feasibility study “Reintroduction of Red Deer in the Fruška Gora National Park” (Ristić et al. 2011). The development and quality of the red deer in the fenced part of this hunting ground (“Ravne” shelter), i.e. males aged 2-8 years, were determined on the basis of the measurements of antlers discarded in the 2010-2014 period.

The measurements of discarded antlers were performed in the manner prescribed by the international CIC formula and the guidelines for the assessment of red deer trophies (Varičak, 2005). Exceptions were the first antlers (spikes) for which the measured parameters were weight, length and the circumference of antler at mid-distance up beam. The parameters of discarded antlers were measured with a metal tape with an accuracy of 1 mm.

The dimensions of discarded antlers from the “Ravne” shelter, which were found in pairs (the left and right beam together) were compared to the dimensions of red deer trophies hunted in northeastern Serbia (Hadži-Pavlović, 1986), whereas the dimensions of discarded antlers which were not found in pairs (a single beam - left or right) were compared with the data reported for the “Lomnička reka” fenced rearing center located in the central part of Mt. Veliki Jastrebac (Gačić et al. 2004). Exceptions were the discarded antlers of 6-year-old males that were found in pairs only. Therefore, in the first analysis, we used the mean value of the parameters (antler length, length of brow tine, length of tray tine, circumference of coronet and circumference of lower beam and upper beam), and in the second analysis, we used the individual values of the above parameters. All statistical analyses (descriptive statistics) were performed with STATISTICA 8.0 (StatSoft).

The data on the spatial distribution and activities of the red deer settled in the wild (open part of the hunting ground) were obtained using three infrared sensor cameras (Dörr SnapShot / Mobil black 5.1), which were placed at five locations from 1st December 2013 to 30th April 2014, and more than 10,000

JPEG images were saved. In addition, we used the data on red deer observation conducted by the professional services of the national park, as well as our own data collected in the “Ravne” shelter.

Results

In the hunting ground Fruška Gora National Park an area called “Ravne” was the selected location for constructing a shelter with a total area of about 100 ha, where the initial stock of red deer native to Hungary (Kaposvár) was settled. The most important goal of this reintroduction was to re-establish a viable population within its indigenous range, which is in accordance with the Guidelines for reintroductions and other conservation translocations (IUCN / SSC, 2013). A total of 36 specimens (5 ♂ and 31 ♀) were settled in the “Ravne” shelter in February 2009. However, the first specimens were released into the open part of the ground in October 2012 (3 ♂ and 6 ♀).



Figure 1 Released red deer in the open part of the hunting ground Fruška Gora National Park

The monitoring of red deer is carried out throughout Mt. Fruška Gora with special attention focused on areas managed by the work units Ležimir, Vrdnik and Beočin. The monitoring is the most intense in the feeding sites in the shape of three rings around the “Ravne” shelter, where the employees of the professional hunting guard service observe the red deer either personally or using infrared sensor cameras (Figures 1 and 2). Our analysis of the JPEG images showed that it is sometimes impossible to reliably determine the (sex and age) structure of the photographed specimens which is particularly true for wild boar.

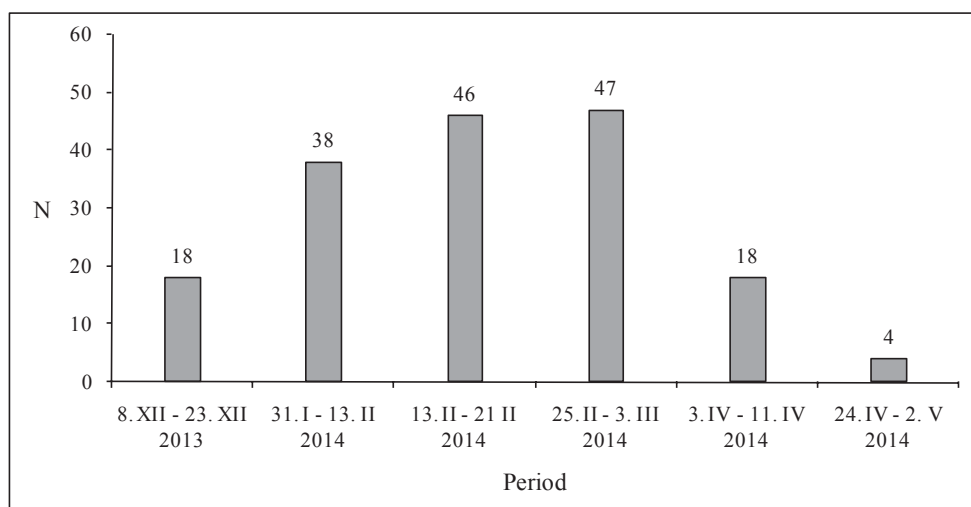


Figure 2 The estimated number of red deer in the third feeding site of the open part of the hunting ground Fruška Gora National Park from 8th December 2013 to 2nd May 2014

So far, a total of 92 specimens (42 ♂ and 50 ♀) were released into the open part of the hunting ground, and no damage was observed to crops, orchards or the discharged red deer. Prior to discharge, a plastic tag was placed on an ear of each individual and their blood was sampled for laboratory analysis (Scientific Veterinary Institute – Novi Sad). In the spring of 2014, the estimated number of red deer in the open part of the hunting ground Fruška Gora National Park (45 ♂ and 55 ♀) was significantly higher than in some other areas in central Serbia, where the settlement of red deer in the open part of a hunting ground was performed much earlier, e.g. in Sokolovica (40 specimens in the spring of 2011) (Gačić et al. 2012a) and Veliki Jastrebac (6 specimens in the spring of 2011) (Gačić et al. 2012b).

Table 1. The values of parameters of the discarded antlers red deer in the fenced part “Ravne” of the hunting ground Fruška Gora National Park (2010-2014)

Age (year)	Parameter	n	Mx	Sd	Cv	Min	Max
2	Weight of antler	-	-	-	-	-	-
	Length of antler	18	40.90	8.24	20.15	23.20	50.40
	Beam of antler	18	6.37	0.83	13.03	4.80	7.90
3	Weight of antler	20	0.73	0.22	30.14	0.50	1.30
	Length of antler	20	60.80	6.07	9.98	51.00	72.30
	Circumference of coronet	20	18.22	1.46	8.01	15.80	20.50
	Lower beam	20	10.26	1.09	10.62	8.10	12.50
	Upper beam	20	8.92	0.87	9.75	6.80	10.20
	Length of brow tine	20	20.70	4.50	21.74	13.70	30.00
	Length of tray tine	20	20.99	5.86	27.92	9.70	32.50
	Length of tray tine	20	20.99	5.86	27.92	9.70	32.50
4	Weight of antler	17	1.18	0.37	31.36	0.70	2.00
	Length of antler	17	70.11	10.58	15.09	54.30	91.00
	Circumference of coronet	17	19.97	2.15	10.77	15.50	23.00
	Lower beam	17	11.73	1.32	11.25	9.60	14.10
	Upper beam	17	10.59	1.20	11.33	8.50	12.60
	Length of brow tine	17	27.70	6.85	24.73	15.20	38.50
	Length of tray tine	16	25.58	5.40	21.11	15.90	36.70
	Length of tray tine	16	25.58	5.40	21.11	15.90	36.70
5	Weight of antler	6	1.67	0.53	31.74	0.90	2.30
	Length of antler	6	82.52	10.68	12.94	67.30	92.90
	Circumference of coronet	6	21.27	2.96	13.92	17.50	25.00
	Lower beam	6	12.40	1.69	13.63	9.90	14.50
	Upper beam	6	11.42	1.46	12.78	9.40	13.10
	Length of brow tine	6	30.18	5.31	17.59	22.90	36.90
	Length of tray tine	6	28.37	7.28	25.66	20.80	39.80
	Length of tray tine	6	28.37	7.28	25.66	20.80	39.80
6	Weight of antler	6	2.20	0.29	13.18	1.90	2.60
	Length of antler	8	90.85	6.96	7.66	82.70	102.00
	Circumference of coronet	8	23.59	2.66	11.28	20.00	27.20
	Lower beam	8	14.26	1.03	7.22	12.80	15.80
	Upper beam	8	13.34	1.20	9.00	11.50	14.90
	Length of brow tine	8	33.32	3.40	10.20	27.20	28.30
	Length of tray tine	8	30.06	3.51	11.68	25.50	34.50
	Length of tray tine	8	30.06	3.51	11.68	25.50	34.50

Our results show that the mean values of parameters of the antlers discarded in the “Ravne” shelter (Table 1) tend to be generally lower than the mean values of parameters of the antlers discarded in the fenced rearing center “Lomnička reka” (Figure 3). For example, the parameters of antlers discarded by male 6-year-old specimens are the following: antler length (90.8 cm < 104.1 cm), length of brow tine (33.3 cm > 33.0 cm), length of tray tine (30.1 cm < 31.9 cm), circumference of coronet (23.6 cm < 24.5 cm), lower beam (14.3 cm > 13.6 cm), upper beam (13.3 cm = 13.3 cm) and weight of antler (2.2 kg < 2.7

kg). These differences can be explained by the fact that a larger number of specimens can be found on a smaller area in the “Ravne” shelter than in the fenced rearing center “Lomnička reka” (107 specimens / 100 ha and 50 specimens / 380 ha, respectively in the spring of 2013).

The length of the first discarded antlers (spikes) from the “Ravne” shelter ranges from 23.2-50.4 cm (Table 1), of which 13 have a length exceeding 30 cm and three reaching over 50 cm. According to these data, the category of poor quality includes all males with the first antlers shorter than 30 cm, similar to the hunting grounds in northeastern Serbia (Hadži-Pavlović, 1986). Also, the author stated that two-year-old males in the area of Deli Jovan and South Kučaj very rarely have their first antlers longer than 50 cm.

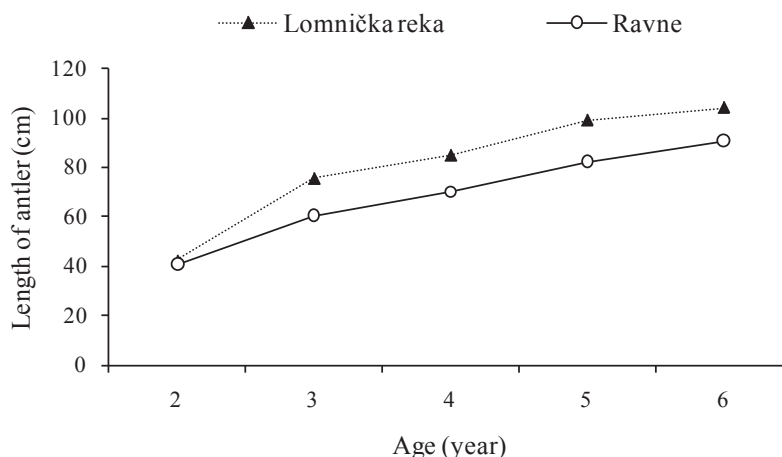


Figure 3 The mean length of the discarded antlers red deer – “Lomnička reka” (Veliki Jastrebac) and “Ravne” (Fruška Gora National Park)

In northeastern Serbia (Table 2) the mean antler length in quality three-year-old males is over 60 cm, while their brow tine and tray tine lengths reach over 25 cm (Hadži-Pavlović, 1986).

Table 2. Antler growth in male red deer in northeastern Serbia (Hadži-Pavlović, 1986) and parameters of discarded antlers in the fenced part “Ravne” of the hunting ground Fruška Gora National Park

Age (year)	n	LA	LBT	LTT	CC	LB	UB	WA	TTS
<i>Northeastern Serbia</i>									
3	3	62.6	26.7	24.8	18.7	9.8	8.8	2.0	-
4	11	71.0	25.8	18.8	19.4	10.9	10.6	3.0	134.9
5-6	25	96.3	34.4	29.2	22.8	13.8	12.6	5.3	175.8
7-8	19	102.4	37.7	31.2	23.4	14.3	13.4	5.9	186.4
9-11	17	106.6	37.7	35.1	24.3	15.3	14.0	6.7	192.3
12-18	10	109.3	39.0	33.3	24.5	15.4	14.1	6.8	192.5
<i>Fruška Gora National Park – fenced part “Ravne”</i>									
3	6	64.6	21.1	22.2	17.5	10.3	8.9	1.4	117.8
4	8	76.0	28.5	29.1	20.1	12.2	10.7	2.6	140.9
5-6	8	84.2	31.1	30.6	22.9	13.6	12.6	4.0	163.8
7-8	3	94.6	36.3	35.5	26.7	15.5	14.3	5.6	187.7

Legend: LA – Length of antler; LBT – Length of brow tine; LTT – Length of tray tine; CC – Circumference of coronet; LB – Lower beam; UB – Upper beam; WA – Weight of antler (kg); TTS – Total trophy score (CIC points).

According to this author, the mean length of antlers in four-year-old males is 71.0 cm, while in quality individuals this parameter can reach over 80 cm. In addition, the mean brow tine and tray tine lengths in quality specimens reach over 30 cm, and their total trophy value may be over 145.0 CIC points. In the “Ravne” shelter the length of discarded antlers of four-year-old males ranges from 64.9-87.5 cm, the length of brow tine ranges from 21.2-34.5 cm and the length of tray tine from 19.9-38.9 cm, which is larger than the sizes of trophies from northeastern Serbia, especially for the length of tray tine and the circumference between the brow tine and tray tine.

In northeastern Serbia (Hadži-Pavlović, 1986), the mean length of antlers of hunted 5-6 year-old males (96.3 cm) was higher by about 25 cm than in the case of four-year-old males. This author stated that quality males had antler length of up to 114.0 cm, while their brow tine and tray tine lengths reached over 35 cm. An average male between the ages of 5 and 6 years in northeastern Serbia reaches a total trophy value corresponding to a bronze medal, while quality individuals could have a trophy value corresponding to a silver medal. However, outstanding individuals, already at this age reach the limit corresponding to a gold medal. In the “Ravne” shelter the mean length of discarded antlers of 6-year-old males (90.9 cm) is higher by about 15 cm compared to the mean antler length in 4-year-old males. These data show that the length of discarded antlers from the “Ravne” shelter is shorter than the length of trophies of their males peers hunted in northeastern Serbia (Table 2). Therefore, an average male between the ages of 5 and 6 years in the “Ravne” shelter reaches the limit corresponding to a bronze medal, while quality individuals can have a total trophy value corresponding to a bronze medal.

The mean antler length of males aged 7-8 years hunted in northeastern Serbia is 102.4 cm (can reach up to 119.0 cm in quality specimens). The following parameters are increasing, although less intensively than in the previous age class: brow tine and tray tine lengths (35-40 cm in quality individuals), the circumference of coronet, the circumference of lower beam and upper beam, and the weight of the trophy (Hadži-Pavlović, 1986). According to this author, males from this age class with less than 6 tines on a single beam, and less than the three well-developed tines in both coronets and no bay tines are very rare and worthless in terms of breeding (undesirable). An average red deer aged 7-8 years has a total trophy value of around 186.4 CIC points (bronze medal). Although the discarded antlers from the “Ravne” shelter have a lower mean antler length (94.6 cm) and tray tine (36.3 cm) length compared to the values found in northeastern Serbia, the mean values of other parameters are higher. However, a more precise comparison of the development of trophies would require further research of the newly-established population in Mt. Fruška Gora and particularly in the open part of the hunting ground.

Conclusion

Our results of measurement and analysis of discarded antlers indicate high quality and good development of red deer males in the “Ravne” shelter (total area about 100 ha). A regular use of digital game cameras in several feeding sites enabled quick improvement of management and additional protection of the released red deer in the open part of the hunting ground Fruška Gora National Park. In addition, a number of other animal species which are important for hunting management were recorded – roe deer, wild boar, brown hare, fox and badger.

In the spring of 2014, the estimated number of red deer in the open part of the hunting ground Fruška Gora National Park was about 100 specimens (45 ♂ + 55 ♀), which is a much greater number compared to some other areas in central Serbia, where the settlement of red deer in the open parts of the hunting grounds was conducted much earlier (e.g. Sokolovica and Veliki Jastrebac). According to the criteria for the assessment of reintroduction success, the settlement of red deer in the Fruška Gora National Park can so far be assessed as successful.

Acknowledgment

The authors would like to thank the Ministry of Education and Science of the Republic of Serbia which financed this paper within project “Establishment of Wood Plantations Intended for Afforestation of Serbia” (TR - 31041), and the Ministry of Agriculture and Environmental Protection - Forest Directorate.

References

1. Bojović D. (1968): Sastav, rasprostranjenje i stanje populacija makrofaune na širem području Đerdapa. Šumarstvo, 7-8, 47-57.
2. Gačić D. (2013): Upporedna analiza stanja lovišta i populacija krupne divljači kojima gazduje JP "Vojvodinašume", Završni izveštaj, Šumarski fakultet, Beograd, 1-61.
3. Gačić D., Danilović M. (2009): Štete od jelena (*Cervus elaphus*) i divlje svinje (*Sus scrofa*) u šumskim lovištima Srbije. Glasnik Šumarskog fakulteta, 99, 15-32.
4. Gačić D., Danilović M. (2011): Stanje i gazdovanje jelenskom divljači u Srbiji. "3. Slovenski posvet z mednarodno udeležbo o upravljanju z divjadjo: jelenjad", Zbornik prispevkov, 45-53.
5. Gačić D., Danilović M., Miletić R. (2012a): Re-introduction of red deer (*Cervus elaphus* L.) in the area of Sokolovica - status and problems. International symposium on hunting "Modern aspects of sustainable management of game population", Proceedings, 22-26.
6. Gačić D., Danilović M., Zubić G., Stevančević D. (2012b): Reintrodukcija jelena (*Cervus elaphus* L.) na područje Velikog Jastrepca - stanje i problemi. Naučni skup lovstva i lovnog turizma sa međunarodnim učešćem, Zbornik radova, 29-41.
7. Gačić D., Popović Z., Novaković N. (2004): Analiza naseljavanja i trofejnih karakteristika jelena (*Cervus elaphus* L.) na području Velikog Jastrepca. Biotehnologija u stočarstvu, 20, 309-316.
8. Gačić D., Popović Z., Novaković N. (2005): Upporedna analiza naseljavanja jelenske divljači u ograđena uzgajališta. Šumarstvo, 1-2, 59-68.
9. Hadži-Pavlović M. (1986): Stanje i karakteristike populacija jelenske divljači u Severoistočnoj Srbiji. Magistarski rad, Šumarski fakultet, Beograd.
10. IUCN/SSC (1998): Guidelines for re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group, Gland, Switzerland and Cambridge, UK, 1-10.
11. IUCN/SSC (2013): Guidelines for reintroductions and other conservation translocations. IUCN Species Survival Commission, Version 1.0, Gland, Switzerland, 1-57.
12. Marinović M. (1930): Privredni značaj lova u Jugoslaviji, Privredni pregled, Beograd, 1-219.
13. (2001): Program razvoja lovstva Srbije 2001-2010, (ed. Šelmić V.), Lovački savez Srbije, Beograd.
14. Ristić Z., Plavša J., Igić R., Marković S., Vukov D., Bjelić Čabrilo O., Armenski T., Dević M., Marković V. (2011): Reintrodukcija evropskog jelena u Nacionalni park Fruška gora. Studija izvodljivosti, Novi Sad, 1-86.
15. (2013): Šumarstvo u Republici Srbiji, 2012. Republički zavod za statistiku, Bilten 567.
16. Varićak V. (2005): Ocenjivanje lovačkih trofeja. Lovački savez Srbije, Beograd, 1-170.
17. Živančević V. (1956): Uzroci propadanja lovne faune u Srbiji. Naučna knjiga, Beograd, 1-72.

ANALYSIS OF THE KEY FACTOR OF GREY PARTRIDGES' MORTALITY

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This paper presents the research results of partial mortality in three major periods of the annual life cycle and their impact on overall mortality in populations of partridges, as an essential attribute of the population dynamics of each species, using the method of analysis of key factors of mortality.

The studies were conducted in the period 2007 - 2014 at an area of 450 ha in the small game hunting ground "Trubarevo", managed by the Faculty of Forestry for over 60 years, located in the southeastern part of Skopje and bordered by suburbs and villages connected with the city, as well as with the most densely populated municipality in the city.

Data collection was performed by complete census, more accurately, by observing of population's strength (in terms of number) at least three times a week. Spring density, i.e. the number of isolated pairs, was determined for the period 01.03. - 15.03., and the autumn density – after collection of most of the crops and the completion of the morphological development of the raised youth, that is, from 20.09. - 10.10. every year. The size of the population after the end of hunting season was determined in the period 15.12. - 31.12.

The results indicate that the key factor in partridges' population dynamics is a variable category in different time periods. Despite the undoubtedly great influence of the chick survival rates in the first weeks of life on total mortality, the losses in winter are very often of essential importance for the changes in the partridges' population density, especially in extremely adverse weather conditions.

Keywords: Grey partridge, mortality, key factor

Introduction

Number of dead individuals of different species of vertebrates and invertebrates in the period between successive phases of the life cycle can be represented as "k" value ("k" as "killing power," *Potts, 1986*).

The term "key factor" was introduced by Morris in 1959 for the mortality factors that cause changes in population density in successive generations (*Varley & Gradwell, 1960*).

Namely, the animal population densities rarely remain constant from one generation to another. Differences in birth rate and mortality that are responsible for these changes can be identified, by counting populations at different stages of the annual cycle. In species with high fertility, the generation changes happen in a relatively short period of time (the average length of grey partridges' life is 7 - 9 months, and the complete generation change is made in 3 - 4 years, *Mottl, 1971*), while mortality factors operate permanently, so that changes in population density can be often interpreted by differences in sub-mortalities during certain specific phases of the life cycle.

For these reasons, the main objective of this study was to determine the effect of partial mortality on total mortality in three consecutive stages of the annual life cycle, that is, the losses in the period of breeding, raising the offspring during hunting season (without culling) and overwintering.

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Material and methods

Studies were carried out in the period 2007 - 2014 at an area of 450 ha, in the part of the hunting ground for small game "Trubarevo", managed by the Faculty of Forestry for over 60 years. The territory belongs to the city of Skopje, and is located southeast of the city's most densely populated municipality and is surrounded by suburbs and villages connected with the city. This is a typical lowland hunting ground with an altitude of 235 to 240 m above sea level, situated at the bottom of the former expanded bed of the Vardar river, now covered with young alluvial deposits. Natural conditions of the habitat and the mosaic presence of planted crops are optimal for the survival of partridges. The territory is made of small individual land parcels bordered by hedgerows, for the most part (80%) with an area of 0.1 to 0.3 ha, while only 10% are larger than 1 ha.

Data collection was performed using the method of comprehensive counting, more precisely, by monitoring the populations' numbers at least three times a week. The spring density and the number of isolated couples were determined in the period 01.03. - 15.03. and the autumn density after harvesting most of the crops and the completion of morphological development of raised young birds, that is in period 20.09. - 10.10. every year. In addition to the total density, the autumn counting included also registration of the number of flocks and the number of partridges in the flocks, which served as a basis for calculations of all population dynamics elements. When collecting these data, we started from the assumption that flock represents two or more individuals (Sekera 1958). Flocks of more than 18 specimens, we counted as one litter, neglecting the possibility of the integration of two or more flocks, as well as joining of adult birds with no offspring. The size of the population after the end of the hunting season was determined for the period 15.12. - 31.12.

The counting was performed with 3 - 4 participants and 2 hunting dogs - pointers of excellent quality. Throughout the period of investigation no reduction of the grey partridge natural predators was made, and the individual specimens that have been shot were taken into account when making calculations.

Spring - summer losses have been calculated as the difference between the autumn environmental density, obtained by counting, and the theoretical autumn density calculated from the spring ecological density and the ideal growth (production of young) by actually separated couple in the spring, that is, by the formulas:

$$I_p = P_{eg}/2 \times 14 \quad \text{and} \quad T_{jg} = P_{eg}/2 \times 14 + P_{eg}, \quad \text{that is} \quad T_{jg} = I_p + P_{eg}$$

The brood size, that is, the average number of chicks in the nest was not determined directly in the field because this element has been explored in detail and varies in narrow limits, and according to many authors it ranges between 14 - 15 individuals (Hell 1965, Soviš 1958, Sekera 1958, Benda 1958, Benda 1960, Chlewski & Panek 1986, Olech 1986, Paludan 1954, Pulliainen 1971, Potts 1980, Potts 1986). For the conditions in the Republic of Macedonia it has been found that the average number of hatched partridge per couple is 14 individuals (Jovetić 1962, Maletić neobjavljeni podaci), so we have been manipulating with this number when calculating the ideal growth, or the theoretical autumn density.

Spring - summer losses are obtained by means of the formula:

$$Plz = (P_{eg} + P_{eg}/2 \times 14) - J_{eg}$$

From the formula $T_{jg} = P_{eg}/2 \times 14 + P_{eg}$ it follows $Plz = T_{jg} - J_{eg}$

Losses during the hunting season were calculated as the difference between the population size at the end of autumn and the hunting stock, that is, before the start of the partridge hunting season, according to the formula:

$$J_z = Z_{eg} - J_{eg}$$

Winter losses have been calculated as the difference between the winter and the spring counting the first following year, or according to the following formula:

$$Zz = Zeg_{(n)} - Peg_{(n+1)}$$

From the formula $Peg/2 \times 14 + Peg = Tjg$ it follows $Plz = Tjg - Jeg$

Abbreviations used in formulas indicate:

Peg – Spring environmental density (breeding density)

Peg/2 – number of couples in the spring counting

Ip – ideal growth

Tjg – theoretical autumn density

Jeg – autumn environmental density

Plz – spring– summer losses

Jz – autumn losses

Zz – winter losses (overwinter mortality);

$Zeg_{(n)}$ – population number at the end of the hunting season

$Peg_{(n+1)}$ – numbers in spring (breeding density) the first following year

For the determination of the key factors we used the method proposed by Varley & Gradwell, (1960), or Podoler & Rogers, (1975), according to which the sub mortalities are to be calculated as the difference between the logarithm of the population density at the beginning and at the end of the certain period of life, according to the formula:

$$k = \log_{10}N - \log_{10}N_s$$

The overall mortality rate is the sum of the partial submortalities and is calculated by the formula

$$K = k_1 + k_2 + k_3 + \dots + k_n$$

where:

N – number of individuals before the action of mortality factors;

N_s – number of survived individuals before the action of mortality factors;

k_1 – spring-summer losses, i.e. mortality from the beginning of nesting to the beginning of hunting season

k_2 – autumn losses, i.e. mortality during the hunting season (without shooting)

k_3 – winter losses, i.e. mortality from the end of hunting season to the beginning of nesting the following year

K – overall mortality including the submortality series $k_1 + k_2 + k_3 + \dots + k_n$

Using logarithms, i.e. "k" values, gives more accurate results than the presentation of mortality expressed as a percentage and gives a better insight into the changes that occur in the same life stages. Using the k values makes it possible to avoid certain statistical problems and errors that can occur when using percentages, i.e. do not require additional mathematical correction (Potts, 1986).

If we show such calculated values on a coordinate system with the "k" values applied on the ordinate axis, it is usually possible to determine the key factor only by visual comparison (Chlewski & Panek, 1985), that is, it's possible to determine the submortality with the greatest influence on overall mortality. Nevertheless, especially in cases where the crucial factor remains unclear by application of the visual method, it is necessary to perform a regression analysis between each submortality and the total mortality, where the key factor, by definition, has the maximum value of inclination, that is, the regression coefficient is the highest (**b**).

For statistical analysis we used the SPSS version 17.0. The correlation between certain parameters was determined by Pearson's correlation coefficient, that is, by linear regression.

Results and discussion

The results of the analysis of key factors of the changing density of the studied partridge populations are shown in Table 1 and Figures 1 and 2

Table 1 The values of the key factors of partridge populations for the period 2007 – 2014

	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
k₁	0,494201	0,562908	0,501757	0,553755	0,509515	0,717453	0,303505
k₂	0,107859	0,112635	0,149862	0,095484	0,120574	0,094556	0,109499
k₃	0,248852	0,244253	0,427562	0,183270	0,397940	0,225779	0,199040
K	0,850912	0,919796	1,079181	0,832509	1,028029	1,037789	0,612044

The graphical representation of the mortality key factor analysis in the studied micro population of grey partridges showed that the overall mortality rate (K) was determined by the difference of partial mortality factors (k₁, k₂, and k₃) at different periods. The overwinter mortality K₃ strikingly follows the movement of the total mortality in the period 2008/09 - 2011/12, while at the beginning and at the end of the study (2007/08 and 20013/14) the losses during nesting and raising the young k₁ have the same change trend with total mortality K (Figure 1), so that for determining the key factor it was necessary to calculate the regression coefficient.

The regression analysis showed that the key factor in the change in the density of the studied partridges micro populations in Macedonia in the period 2007 - 2014 were the spring - summer losses. The line regression of this parameter in relation to total mortality had the greatest slope ($b = 0.539$), with relatively little difference compared to the value of the regression coefficient of winter losses ($b = 0.413$) (Fig 2). However, if we exclude the last year of study from the analysis, the winter losses appear to be the key factor ($ZZ - b = 0.708$, $Plz - b = 0.177$), as a result of minimum population mortality in the spring and summer of that year compared to the entire study period.

Although the use of mortality key factors analysis, primarily in population studies of insects, does not explain all the aspects of mortality in the population and often can not detect the changes and correlations between the partial and the total mortality (Yamamura, K., 1999, Putman and Wratten, 1984), this method was applied by a number of researchers in population dynamics precisely about the partridges, in order to explain the effect of mortality in different stages of the annual life cycle on total mortality, and thus contribute to the protection and better management of these game species populations.

Thus, for example, the exploring of three different partridge micropopulations in Macedonia in the period 1987-1990 (Maletic, unpublished data) found that the key factor in mortality for all three micropopulations were the winter losses. However, in the partial analysis, the losses in the winter period occurred as a key factor in only two micropopulations, while in one of them it was the spring - summer losses. It must be said that losses during the autumn were counted as losses in the winter period, that is, the overall mortality was divided into two partial submortalities (k₁ and k₂).

Similar problems in determining the significance of differences in seasonal mortality in the population dynamics of grey partridges were described by Chlewski & Panek (1985), who divided the overall mortality into three submortalities - losses on eggs and chicks k₁, losses from spring to autumn, k₂, from which they excluded the previous one, and the winter losses K₃. According to this survey, conducted in the period 1968 - 1977 the key factor in the losses were the losses in eggs and chicks. However, with exclusion of the last two years of research, that is, if we analyse only the period '68 - '75 year, the winter losses become the key factor. The exclusion of the results from '76 and '77 were justified by the authors with the apparent qualitative changes in the population dynamics in those years, when a drastic decline in numbers occurred, resulting in low numbers that have never been recorded before. The powerful effect caused by the increased losses of eggs and chicks in these two years on the overall mortality rate is explained by the fact that these losses were more important than the winter losses, calculated for the entire studied period. Therefore, the analysis of key factors have shown that in the period '68 - '75 the winter losses were the most important factor responsible for fluctuations in the populations of grey partridges.

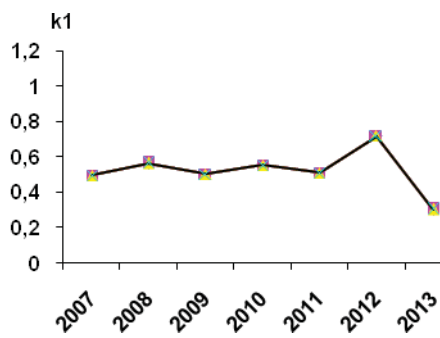
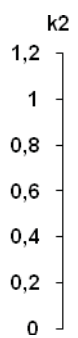
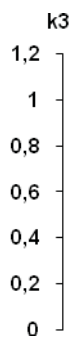
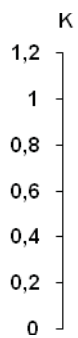


Fig.1 Graphical representation of the key factor analysis

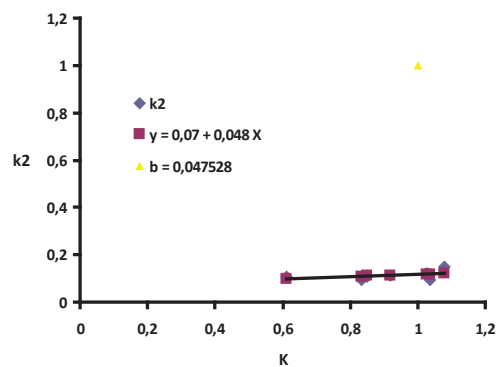
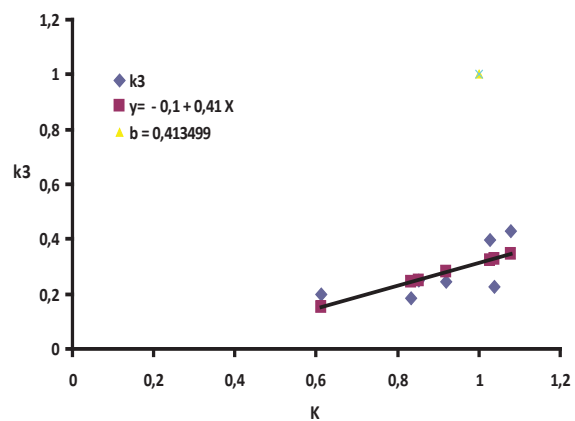
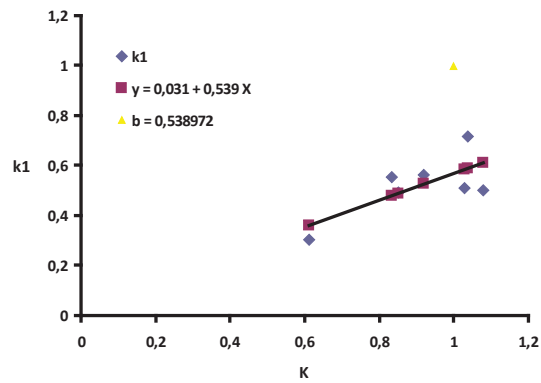


Fig.2 Model of linear regression key factor

In Great Britain, Podoler & Rogers (1975), by reanalysis of the study of Blank, Southwood & Cross (1967), divided the overall mortality in the annual life cycle of partridges in as much as 9 stages: Variations in the brood size, brood reduction in repeated nests, unfertilized and unsuccessful eggs, destroyed and unrepeatable nests, mortality of chicks in the first 5 weeks of life, mortality by shooting (August - December), the other losses in the same period (emigration, predation, etc.), losses in spring and failure in the formation of pairs, i.e. surplus of males. The results of this reanalysis showed that the mortality of chicks in the first 5 weeks of life has the greatest impact on overall mortality, that is, it is the key factor in population dynamics of this species. Despite the differences of the methodological approaches in determining the seasonal submortalities, these results essentially confirm our findings.

In Hungary, Faragó, S. et al. (2012), during twenty years of research of grey partridges population parameters and using the same method, they found that the mortality key factors were losses of the eggs and chicks and winter losses.

The research of the game population dynamics should not only detect and isolate the factors that cause mortality in certain development stages, but should also offer acceptable solutions and actions to improve the situation. Thus, Sotherton et. all. (2014) give a review to the long-term studies of the grey partridge in the UK, and among other things, to the mortality key factor. On the basis of these results they have developed and implemented a "case study" management model for this game at 6 farms in Eastern England. From 2002 to 2007 they implemented measures in order to increase the partridges population density at the experimental area, namely: controlling the number of predators, habitat management in order to increase the number of nests, brood-rearing and the overwinter cover, as well as supplementary nutrition. Implementation of these measures has led to a significant increase in partridge density in the study area, while the increasing in density at the control site in the given period was very little (2.9 to 18.4, 1.3 to 4.2).

Unlike them, Bro et al. (2004) in their research of the impact of habitat management on grey partridges populations in France for a period of six years, tested the effectiveness of raising mosaic belts with corn and kale plantations as measures to increase the breeding density of the population and the winter survival of the partridge, and they came to completely opposite results. Monitoring of population elements (breeding density, reproductive success and overwinter mortality) has not confirmed the positive impact of plantation to the increase of the density of grey partridge population in comparison with the control area.

Conclusion

Fluctuations in numbers, both seasonal and in longer periods are one of the main characteristics of all types of game, especially of species with rapid change of generations, such as the grey partridge. In addition, these species inhabits biotopes heavily influenced by anthropogenic factors, in which, during a single reproductive season, there are drastic changes of environmental conditions that influence their survival (Maletić et al. 2013).

The key factor in the population dynamics of partridges is a variable category in different time periods. Despite the undoubtedly great influence of survival rates of chicks in the first weeks of life and breeding coefficient to total mortality (Maletić, 2006, Maletić et al. 2012), the losses in winter very often are of essential importance for the population density of grey partridges, especially in extremely adverse weather conditions. Namely, although the true impact of climate is often disguised as the average values of some of its parameters (air temperature, humidity, precipitation ...), which usually do not go beyond the long-term average for a wider area, of the utmost importance for the survival of partridge youngs are the fast, brutal and long-term changes in meteorological elements at the most critical period (May, June and July), especially when, as is most often the case, they operate complexly (Maletić, 2007). On the other hand, the large variability of spring ecological density, that is, the breeding populations, of decisive influence are the disastrously adverse conditions

in the winter, when the losses may be greater than the periodic environmental growth in the same year (Maletić, unpublished data).

References

1. Aebischer, N., Kavanagh, B., Hagemeyer W.J.M., Blair, M.J. (1997): The EBCC Atlas of European breeding birds, their distribution and abundance, Poyser, London, 212 – 213.
2. Benda, R. V. (1958): Jahresberichte von Burgate – Manor, Wild und Hund 61, 12.
3. Benda, R. V. (1960): Jahresberichte von Burgate – Manor, Wild und Hund 63, 12.
4. Blank, T. H., Southwood, T. R. E., Cross, D. J. (1967): The ecology of the partridge I. Outline of the population processes with particular reference to chick mortality and nest density. *Journal of Animal Ecology*, 36, 549-556.
5. Bro, E., Mayot, P., Corda, E., Reitz, F. (2004): Impact of habitat management on grey partridge populations: assessing wildlife cover using a multisite BACI experiment. *Journal of Applied Ecology*, 41, 846-857.
6. Chlewski, A., Panek, M. (1986): Population dynamics of the partridge on hunting grounds of Czempin, Poland. *International Symposium Common Partridge, Poland, Proceedings*, 143 – 156.
7. Faragó, S., Ditttrich, G., Horváth-Hangya, K., Winkler, D. (2012): Twenty years of the grey partridge population in the LAJTA Project (Western Hungary). *Animal Biodiversity and Conservation*, 35.2, 311-319.
8. Hell, P. (1965): K niektorým otazkam jarabic v Zapadoslovenskom kraji. *Zool. listy* 14, 37 – 46.
9. Јоветић, Р. (1962): Прилог изградњи методике у ловству, Год. зборник на Земјоделско -шумарскиот факултет Универзитет – Скопје, Книга XV, 1962.
10. Maletić, V. (2006): Parametars Fecundity in Partridge. 17th Symposium on innovation in animal science and production, *Biotechnology in animal husbandry*, vol. 22, 421 – 427, Belgrade – Zemun.
11. Maletić, V. (2007): Influence of some meteorological elements on real periodical increase of common partridge. *International Symposium Sustainable forestry – problems and challenges, Ohrid, Proceedings*, 108-113.
12. Maletić, V., Stojčevski, D., Beuković, D., Lavadinović, V. (2012): Elements of the population dynamics of the grey partridges (*Perdix perdix* L.) in suburban habitats. *International symposium on hunting Modern aspects of sustainable management of game population in Zemun-Belgrade, Proceedings*, 16-21.
13. Maletić, V., Stojčevski, D., Lavadinović, V. (2013): Winter mortality in the population of grey partridges (*Perdix perdix* L.). The 2nd international symposium on hunting Modern aspects of sustainable management of game population in Novi Sad, *Proceedings*, 100-105.
14. Maletić, V., neobjavljeni podaci
15. Mottl, S. (1971): Bulletin special du Conseil Supérieur de la Chasse, 15,
16. Olech B. (1986): Changes in numbers of Partridges in Poland in 1964 – 1984, *International Symposium Common Partridge, Poland, Proceedings*: 111 - 122
17. Paludan, K. (1954): Agerhonens Ynglesæson 1953. *Danske Vildtunders* 3, 1 – 20, 1954.
18. Podoler, H., Rogers, D. (1975): A new method for the identification of key factors from life table data, *Journal of animal ecology* 44, 85-115.
19. Potts, G. R. (1980): The effects of modern agriculture, nest predation and game management on the population ecology of partridges *Perdix perdix* and *Alectoris rufa*. *Advances in Ecological Research* 11, 2 – 79.
20. Potts, G. R. (1986): *The Partridge: Pesticides, predation and conservation*. London: Collins.
21. Pulliainen, E. (1971): Clutch-size of the partridge (*Perdix perdix* L.), *Ornis Scandinavica* 2, 69 – 73.
22. Putman, R. J., Wratten, S. D. (1984): *Principles of Ecology*, University of California, Press.
23. Sekera, I. J., (1958): Causes of the variation and diminution of the partridge populations in Czechoslovakia. *Lesnictvi* 5, 493 – 500.
24. Soviš, B., (1958): Poznamky k situácii v chove jarabic so zreteľom na tehorocny odstrel, *Polovnicstvo a Ribarstvo* 10: 7.
25. Sotherton, N. W., Aebischer, N. J., Ewald, J. A., (2014): Research into action: grey partridge conservation as a case study. *Journal of Applied Ecology*, Volume 51, Issue 1, 1-5.
26. Varley, G., Gradwell, G. R., (1960): Key factors in population studies. *Journal of animal ecology* 29, 399-401.
27. Yamamura, K. (1999): Key-factor/key-stage analysis for life table data, *Ecology* 80 (2), 533-537.

THE PRESENCE OF BIRDS AND OTHER ANIMALS, THEIR DISPERSION AND SECURITY INDICATOR AT THE AIRPORT NIKOLA TESLA

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Summary: This paper comprises the analysis of the problem with presence of birds as well as other animals at the airport Nikola Tesla Beograd as well as activities of the Department of physical and technical protection of the airport from the birds and other animals to reduce the risk of bird strike to aircrafts. According to the evaluative indicators it can be clearly seen that the value at our airport is reaching the limit of about 0.3 bird strikes per 1000 operations (take-off and landing of aircraft), which clearly proves that we are below the international recommendations for collision of birds and aircraft ranging to 1 bird strike per 1000 operations.

Dispersion of the birds and other animals in 90.58% of cases was performed with acoustic systems (sirens, bioacoustics system and megaphone), in 8.27% of cases dispersion was performed with hand-held laser device, while dispersion by firing of weapons (Department of physical security) was performed in 1.15% of cases. Among the most problematic birds we can single out the birds from crow family (rook, black crow and jackdaw) and gulls (blue gull, river gull) - they have share of 86.14% of dispersing birds. Activity of birds was most expressed from May to October.

The presence of birds around airports is caused by the presence of places where they can reproduce, as well as the feeding base that is used in their feeding at certain times of the year.

Key words: Airport, birds, safety indicators

Introduction

One of the threats to the safety of air traffic are birds and other animals. Increasing of human population and the volume of air traffic, there is an increased risk of bird strike on an aircraft. When we add an attractive location, habitat, residences near the airport (landfills, tree lines), it increases the risk of bird strikes.

Airport "Nikola Tesla" Belgrade (ANT) is for decades dealing with problems of birds and other animals. At the end of the 1990s Airport Nikola Tesla Belgrade has recognized that birds present a threat to aviation security and commenced with the implementation of active measures for the monitoring and dispersion of birds from the airport areas in accordance with the Air Transport Law ("Official Gazette of the Republic of Serbia", No 73/10 and No 57/11) article 116. These measures have been under the jurisdiction of the Department of physical security which these activities dealt until the establishment of the operational activities of the specialized Department of physical and technical protection of the airport from the birds and other animals. In the period from the commencement of activities to 2011th the information that have been received about activities and events (confirmed or unconfirmed collisions of birds and other animals with an aircraft) at the Airport "Nikola Tesla" Belgrade were incomplete and unsorted, and thereby information were not reconciled with Civil Aviation Directorate of the Republic of Serbia (hereinafter referred to DCV).

Material and Methods

This paper used data from the evidence record of observations and dispersion of birds and other animals by Department of physical and technical protection of the airport from the birds and other animals at Airport "Nikola Tesla" Belgrade. From 2011, properly evidence keeping of activities of birds and other animals in the Security Restricted Area (ORZ), implementation of measures dispersing,

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UDC: 568.2

analysis of the occurrence of birds, the classification of events, as well as compliance of number of events with DCV begun.

The data of three categories of events of bird strike under the jurisdiction of ANT, bird strike beyond the jurisdiction of ANT, potential bird strike as well as safety indicator for the period 2011-2013 were analyzed.

Jurisdiction in the collision of birds and aircraft (on landing 200ft, and 500ft takeoff) was taken from the ICAO recommendations (Airport Service Manual, Part 3, Bird Control and Reduction, Chapter 10). Rating category of events related to birds is taken from the ICAO bird strike information system – IBC (Standard 6).

For year 2013 we analyzed assets that we applied in dispersing birds and other animals, total number of dispersing as well as shown number of identified bird species and other animals.

Assets that we applied were classified into three groups: acoustic system, handheld laser devices, firearms (Department of Physical Security- FTO).

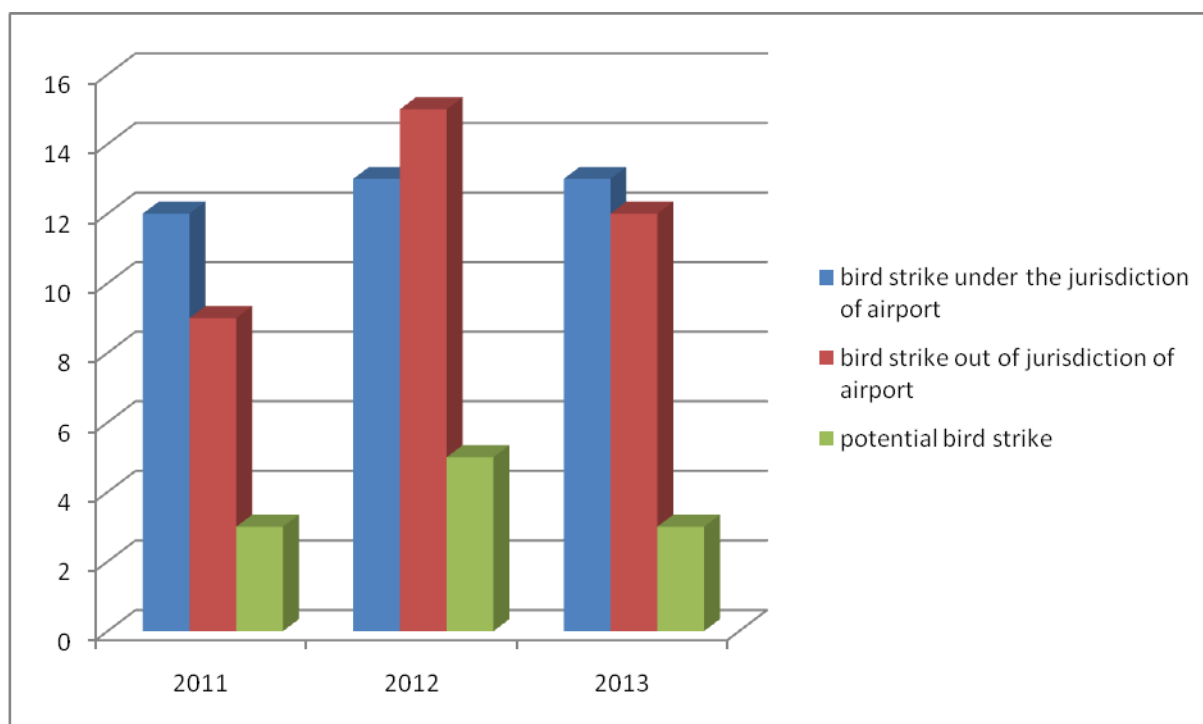
Results

In period 2011-2013 84 of noted bird collisions with aircraft were recorded. In 2011 at Airport Nikola Tesla were noted a total of 24 reported events of which 12 were in jurisdiction of ANT, 9 were rated as application of events out of jurisdiction of ANT, while 3 were rated as potential hazards (birds flyover, presence of birds, etc).

During 2012 there were a total of 32 reported events of which 13 were confirmed to be under the jurisdiction of ANT, 14 were rated as report of events out of jurisdiction of ANT, while 5 were rated as potential hazards (birds flyover, presence of birds, etc).

In 2013 total of 28 reported events were noted at airport, 13 of them were under the jurisdiction of ANT, 12 were rated as report of events out of jurisdiction of ANT, while 3 were rated as potential hazards. (Chart 1)

Chart 1: Showing three categories of events related to birds in 2011, 2012, 2013



According to statistics, AD Airport "Nikola Tesla" Belgrade, during 2011, 2012 and 2013 has recorded a steady increase in airline operations, while the number of collisions of birds and aircrafts in jurisdiction of the airport remained almost unchanged, with deviations of +1 (Table 1). According to data

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obtained from many airlines, allowed number of collisions of birds and aircrafts is 1 per 1000 operations. While according to international recommendations it goes up to 2 strikes per 1000 operations, depending on which country prescribes the limit. According to the evaluative indicators it can be clearly seen that that value reaches the limit of about 0.3 bird strike per 1000 operations, which clearly proves that we are below the above listed level.

Table 1: Comparative review of safety indicators for 2011.,2012. i 2013..

No.	Year	Number of aircraft operations	Number of reported events	Value of safety indicators
1.	2011	44.923	12	0.0002672 or 0.27 per 1000 operations
2.	2012.	44.989	13	0.0002889 or 0.29 per 1000 operations
3.	2013.	46.828	13*	0.0002776 or 0.28 per 1000 operations

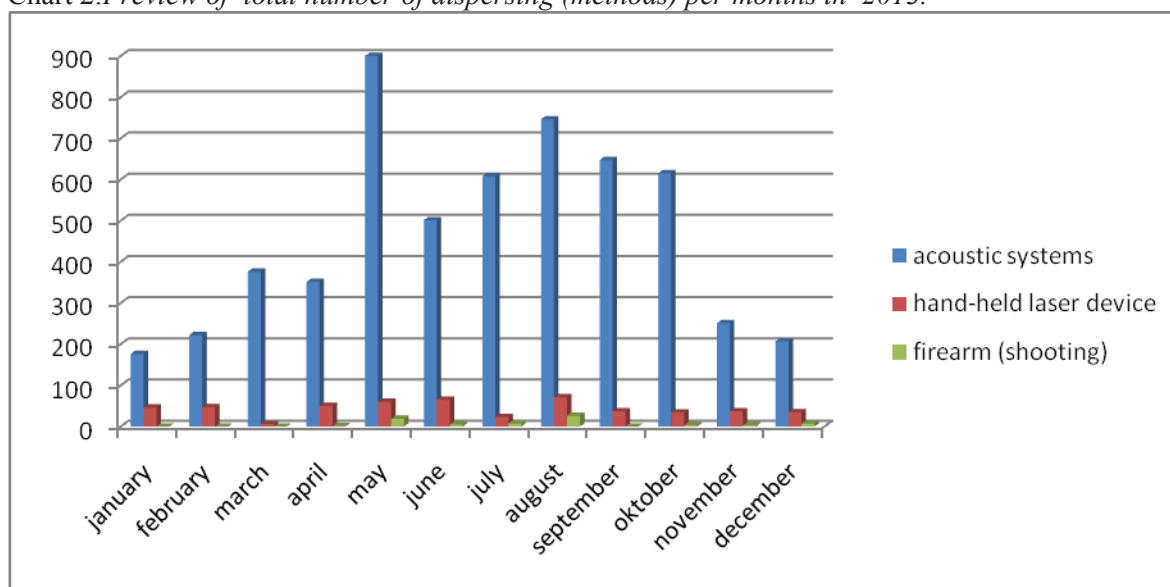
*13 of confirmed collisions of birds and aircrafts, which happened in jurisdiction of airport (2013), 11 collisions happened during the office hours of Department of FTO, while 2 collisions happened out of hours of Department of FTO.

Analysis of the evidence records of watching and dispersing birds and other animals showed that in 90,58% of cases dispersing was performed with acoustic systems (sirens, bioacoustics systems, megaphone), in 8,27% of cases dispersing was performed with hand-held laser devices, while shooting from firearm (Department of Physical Security) was performed in 1,15% of cases (Table 2). Analysis of evidence records clearly determines in which period activity of birds was highest and which methods of dispersing were the most prominent by month (Chart 2).

Tabel 2: *Applied assets in dispersing birds and other animals in 2013*

Applied assets in dispersing	Number	%
Acousticsystems	5600	90.58
Hand-held laser device	511	8.27
Firearm (shooting)	71	1.15
Total:	6182	100

Chart 2: *Preview of total number of dispersing (methods) per months in 2013.*



Everyday observation and evidencing of the bird presence showed that the airport “Nikola Tesla” area constantly or from time to time is being used as habitat, resting or feeding area by the following

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birds: gulls (*Laridae*) - blue gull (*Larus cachinnans*), river gull (*Larus ridibundus*); crows (*Corvidae*) - Hooded Crow (*Corvus corone cornix*), Rook (*Corvus frugilegus*), Jackdaw (*Corvus Mondel*), Magpie (*Pica pica*); pigeons (*Columbidae*) - Wild Rock Dove (*Columbia livia*), Wood Pigeon (*Columbia palumbus*), Collared Dove (*Streptopelia decaocto*); House Sparrow (*Passer domesticus*); House Martin (*Delichon urbica*), Barn Swallow (*Hirundor rustica*); Buzzard (*Buteo buteo*), Pheasant (*Phasianus colchicus*); Starling (*Sturnus vulgaris*); Kestrel (*Falco tinnunculus*), etc. (Table 3)

It was also determined that “Nikola Tesla” airport area is constantly or from time to time visited by the following species of mammals: fox (*Vulpes vulpes*), stray dogs (*Canis lupus familiaris*), wild boar (*Sus scrofa*), cats (*Felis silvestris catus*), hare (*Lepus europaeus*), hedgehog (*Erinaceus europaeus*), weasel (*Mustela nivalis*), rats (*Rattus*), Common voles (*Microtus arvalis*)

Table3: Preview of the number of identified species of birds and other animals in 2013 and their percentage share in the total number

Type	Number	%
Birds	5959	96.39
Crow	4966	80.33
Gull	359	5.81
Stork	20	0.32
Pheasant	70	1.13
Starling	186	3.01
Buzzard	193	3.12
Kestrel	132	2.13
Pigeon	30	0.48
Swallow	3	0.05
Other animals	223	3.61
Dog	126	2.04
Cat	33	0.53
Fox	51	0.82
Hare	13	0.21
Total:	6182	100%

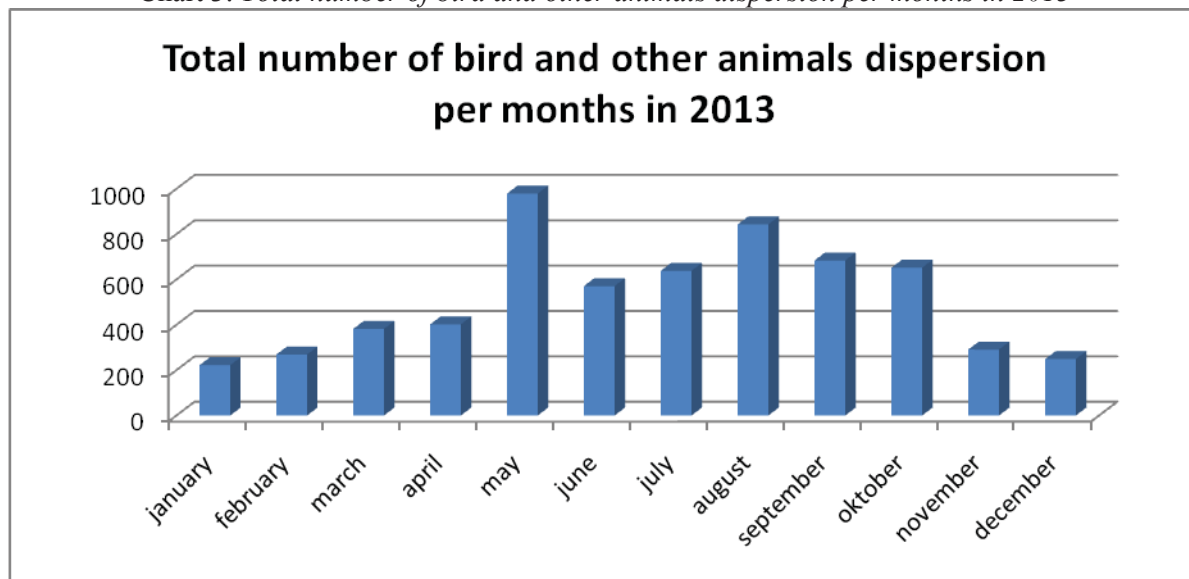
Given this data it can be concluded that in 96.39% cases in 2013 birds were dispersed from airport's ORZ and that in 3.61% cases other animals were dispersed (Table 3). Among the most problematic birds from the family of crows (rook, black crow and jackdaw) and gull (Caspian gull and river gull) can be singled out – share of 86.14% of total bird dispersion.

Based on the data processing through the monthly records of monitoring and dispersion of birds and other animals in 2013, we obtained the parameters indicating the seasonal occurrence and activity of birds and other animals in ORZ (Chart 3).

It is worthy to mention that the bird activity had its peak from May to October, especially in May, since there was a lot of rainfall causing the increased bird activity.

The base earth cover on airports, historically speaking, was always a grass sward even though large grass surfaces can attract various risky species of birds (Seamans et al., 2007; Washburn and Seamans, 2007; Washburn et al., 2007). Maintenance of grass surface on airports is expensive regardless of the composition of the grass types and height of mowing of lawns. An attractive alternative would be to place earth covers on some parts of airport properties which would bring gain and not spend funds.

Chart 3: *Total number of bird and other animals dispersion per months in 2013*



Even with relatively different agricultural surfaces, the birds rarely use fields under crops in comparison with the surrounding types of habitat. Birds are generally more common in bushy-tree oasis, in the woods, on damp soil, where opportunities for nesting and food sources are much more bountiful (Blokpoel, 1976; Best et al., 1995, 2001; Patterson and Best, 1996; McMaster and Davis, 2001). Often anthropogenic disturbance, low diversity of plant species and the use of pesticides contribute to the relatively poor representation of a bird on root crops. Based on the literature preview it is evident that some authors do not recommend the cultivation of crops in the immediate vicinity of the airport (Blackwell et al., 2009, Devault et al., 2009). This is because of the fact that in some phases of growth they can find themselves on the menu of various bird species but more due to accompanying agrotechnic that attracts rodents important in the food chain of feathered predators, and the inhabitants of the ground, mostly invertebrates, which all together represent a potential hazard to the safe air traffic. Nevertheless, the reality in most countries with intensive agricultural production is that in the immediate or distant areas around airports are surfaces under different agricultural crops. In growing crops the system of crop production - crop rotation must be respected.

Conclusion

In the period from 2011-2013 there was 84 reported events of aircraft collision with birds. In 96.39 % cases in 2013 birds were dispersed from Secured Restrictive Zone of the airport and in 3.61% cases other animals. Among most problematic birds we can single out birds from the crow family and gull family – share of 86.14% of total bird dispersion.

On the basis of the value indicators of about 0.3 bird strike per 1000 operations (takeoff and landing of aircraft), airport Nikola Tesla Belgrade is below international recommendations for collisions of birds and aircrafts which ranges up to 1 bird strike per 1000 operations.

Activity of birds comes to the fore mostly from May to October.

The Presence of birds around airport is caused by presence of places where they can be reproduced, as well as feeding base which they use in their feeding at certain times of the year.

References

1. Best, L. B., Bergin, T. M., Freemark, K. E. (2001): Influence of landscape composition on bird use of rowcrop fields. *J. Wildl. Manage.* 65, 442–449.
2. Best, L. B., Freemark, K. E., Dinsmore, J. J., Camp, M. (1995): A review and synthesis of habitat use by breeding birds in agricultural landscapes of Iowa. *Am. Midl. Nat.* 134, 1–29.

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3. Blackwell, B. F., Huszar, E., Linz, G., Dolbeer, R. A. (2003): Lethal control of red-winged blackbirds to manage damage to sunflower: an economic evaluation. *J. Wildl. Manage.* 67, 818–828.
4. Blokpoel, H. (1976): *Bird Hazards to Aircraft*. Clarke, Irwin & Company Limited.
5. Devault, T., Kubel, J., Rhodes, O., Dolbeer, R. (2009): Habitat and Bird Communities at Small Airports in the Midwestern USA. *Proceedings of the 13th Wildlife Damage Management Conference, Prevention and Control of Avian Damage*, 137-145.
6. ICAO BIRDSTRIKE INFORMATION SYSTEM – IBC, Standard 6 (2006), Montreal - Canada.
7. ICAO document 9137 (Airport Service Manual, Part 3, Bird Control and Reduction, Chapter 10)
8. McMaster, D.G., Davis, S.K. (2001): An evaluation of Canada's permanent cover program: habitat for grassland birds? *J. Field Ornithol.* 72, 195–325.
9. Patterson, M. P., Best, L. B. (1996): Bird abundance and nesting success in Iowa CRP fields: the importance of vegetation structure and composition. *Am. Midl. Nat.* 135, 153–167.
10. Seamans, T. W., Barras, S. C., Bernhardt, G. E., Blackwell, B. F., Cepek, J. D. (2007): Comparison of two vegetation-height management practices for wildlife control at airports. *Human–Wildl. Confl.* 1, 97–105.
11. Washburn, B. E., Barras, S. C., Seamans, T. W. (2007): Foraging preferences of captive Canada geese related to turfgrass mixtures. *Human–Wildl. Confl.* 1, 188–197.
12. Washburn, B. E., Seamans, T. W. (2007): Wildlife responses to vegetation height management in cool-season grasslands. *Rangel. Ecol. Manage.* 60, 319–323.
13. Air Transport Law ("Official Gazette of the Republic of Serbia", No 73/10 and No 57/11) Article 116

MITOCHONDRIAL DNA POLYMORPHISM IN POPULATION OF EUROPEAN ROE DEER (*CAPREOLUS CAPREOLUS*) FROM VOJVODINA

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Summary: Roe deer (*Capreolus capreolus*) populations from Serbia were previously genetically characterized based on allozyme and mtDNA sequence variability. Populations from Vojvodina were described as populations with high genetic diversity and higher inbreeding level. MtDNA diversity was higher in roe deer from Serbia, than elsewhere in Europe. In last decade lower fertility rate have been detected in roe deer populations from Vojvodina. Thus, the aim of this study was to explore genetic diversity of roe deer population from Vojvodina based on mtDNA polymorphism and to infer information on possible reduced genetic variability. In the present paper we present our first results on mtDNA polymorphism in roe deer population from Vojvodina.

Material and Methods: A fragment of 452bp mtDNA control region was successfully amplified for 12 roe deer individuals sampled in 2014 in Nova Crnja, Novo Miloševo and Novi Bečej hunting grounds and sequencing was performed.

Results: We observed a high genetic diversity in roe deer population from Vojvodina. Eight different haplotypes were detected. Haplotype diversity was $h=0.909\pm0.065$; nucleotide diversity $\pi=0.013$ and average number of nucleotide differences $k=5.955$. In total 17 polymorphic sites were found, among which 9 were parsimony informative. Mismatch analyses supported a pattern of demographic expansion ($S_{sd} = 0.044$, $p = 0.17$), as well as negative values of neutrality tests (Fu's $F_s = -0.588$, $p=0.201$; Tajima's $D = -0.250$, $p>0.10$).

Conclusion: High genetic variability was detected in roe deer population from Vojvodina based on mitochondrial DNA sequence variability. Our preliminary results indicate that no decline of genetic diversity is present, comparing to previously published data. Furthermore, population expansion was registered. Nevertheless further studies with more variable genetic markers are needed to confirm this result and to gain more detail information on roe deer population structure.

Key words: mtDNA, roe deer, Vojvodina

Introduction

Roe deer (*Capreolus capreolus* L.) is a species of medium-sized ungulates, which inhabits a wide area of Europe (Coulon et al., 2006). The range of distribution in Europe is from southern Spain to northern Scandinavia, including western Russia, the Urals (Vor et al., 2010), the southern Apennines in Italy and the southern Balkans (Royo et al., 2007). The exceptions are Ireland, and some of the Mediterranean islands (Sommer et al., 2009). Outside Europe, there are occasional populations in Turkey, Israel and Jordan.

Several studies, mostly based on mtDNA, revealed that roe deer populations in Europe show a significant substructuring (Royo et al., 2007). It seems that the cyclical expansion of permafrost, from the north, had to force the roe deer population to retreat to southern refugias, while during interglacialization periods recolonisation of Central Europe has happened (Randi et al., 2004). Three regions of southern

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Europe have been identified as potential refugia: the Iberian Peninsula, Italy and the Balkans (Royo et al., 2007). In addition to historical processes, anthropogenic influence left an impact on the genetic diversity of populations of roe deer, primarily deforestation, excessive hunting and reintroduction of non-native animals (Randi et al., 2004).

Roe deer has a strong socio-economic impact, through hunting activities (one of the most important hunting game in Europe), the risk of traffic troubles and disease transmission to native species and humans, and adequate management of this species is necessary (Galan et al., 2003).

Roe deer populations are one of the genetically most variable game species populations (Hartl et al., 1991). One of the molecular markers which gives first test of population structure is mtDNA sequence variation. mtDNA is a marker which can be used to reconstruct historical patterns of population demography, biogeography and speciation. The fact that mtDNA can easily be amplified in a large number of taxa, and that it is haploid, justifies the choice of this molecular marker in the population-genetic and phylogenetic studies. The results of population-genetic structure and phylogeography of the species are used in the development of appropriate strategies of conservation and management of populations (Royo et al., 2007).

The aim of this study was to analyse the sequence variability of the first hypervariable domain of the mtDNA control region, in a population of roe deer (*Capreolus capreolus* L.) from Vojvodina (Serbia) in order to identify present haplotypes and their relations, to calculate the main parameters of genetic variability and to reveal the potential scenario of further development of the population of interest.

Material and Methods

In total, 14 roe deer individuals were collected from the 3 localities in Vojvodina: Nova Crnja, Novo Milosevo and Novi Becej during 2014. Muscle tissue of each individual was sampled and frozen at –20°C immediately after the death of the animal.

Total DNA was extracted and hypervariable domain of the mitochondrial control region (CR-1) was amplified following Royo et al. (2007). Approximately 100ng of genomic DNA were amplified in a total volume of 20µl containing 0.2mM dNTP, 0.5 µM of each primer, 2U Taq polymerase (Fermentas) and 1x reaction buffer. PCR amplification conditions were as follows: initial step of denaturation at 94°C for 5 min, followed by 35 cycles of amplification – each cycle being 94°C for 30 s, 55°C for 30s and 72°C for 1min – and a final extension step at 72°C for 10 min. The PCR products were purified following the ExoSAP protocol (Fermentas) and sequencing was conducted on an ABI3730xl DNA Analyzer using BigDyeTerminator v3.1 Cycle Sequencing Kit.

Obtained sequences were aligned using the Clustal W algorithm implemented in BioEdit v7.0.5.3 (Hall 1999). After alignment dataset comprised 12 sequences of total length of 452 nucleotides. Basic indices of genetic diversity, number and haplotype diversity (H_d), nucleotide diversity (π) and average number of nucleotide differences (k) were calculated in DnaSP v.5.10.01 (Librado and Rosas, 2009). Same program was used for the neutrality tests (Fu and Li, Fu and Tajima tests) and mismatch analysis. Median joining network of obtained haplotypes was constructed in Network 4.1.1.1. (<http://www.fluxus-engineering.com>).

Results

Amplification of the target fragment in 14 roe deer individuals, resulted in 12 sequences with adequate quality (the two sequences are characterized as ineligible, and were not included in the analysis).

Comparison of the 12 sequences of 452 nucleotides in length identified 8 different haplotypes with the 17 variable sites (a total of 17 mutations, the type of the transition) (Tab. 1). Haplotype diversity was high ($H_d = 0.909 \pm 0.06$). The nucleotide diversity value was $\pi = 0.0131$, and the average number of nucleotide differences $k = 5.955$. Within the identified haplotypes two had slightly higher frequency: H1 (25%) and H2 (25%) (Tab. 2). The remaining 6 haplotypes were unique.

Similar haplotype diversity values were obtained for the populations of roe deer from the Alps and central Italy, analyzed by Randi et al. (1998) ($H_d = 0.93$), as well as for roe deer populations over wide areas of Europe ($H_d = 0.971 \pm 0.002$) (Randi et al., 2004). Lorenzini et al. (2006) show that haplotype diversity vary between high in Romania ($H_d = 0.822$), to quite low in Greece ($H_d = 0.333$). Slightly lower values of haplotype diversity were observed in studies of populations from Great Britain ($H_d = 0.81$)

(Baker et al., 2011). The high value of haplotype diversity in roe deer population in Vojvodina was expected, since it is well known, on the basis of previous studies, that the mtDNA diversity of populations from Western Balkan countries is particularly high (Randi et al., 2004).

Fu's F_s statistics, based on the total number of segregations (Fu 1997), resulted in a negative (-0.588), but not significant value ($p = 0.201$ $p > 0.10$). Tajima's D test of neutrality based on the difference between the total number of segregation sites and the average number of nucleotide differences (Tajima 1989), proved to be positive ($D = 0.2506$), but not significant ($p > 0.10$). Mismatch analysis showed unimodal distribution. All tests may indicate past population expansion.

Table 1. Detected CR-1 mtDNA haplotypes and variable sites

Haplotype	Variable sites															
	91	97	111	116	124	155	223	228	236	262	280	290	298	315	337	400
H1	A	T	G	G	A	G	T	A	A	G	A	C	T	T	C	A
H2	.	C	.	A	.	A	C	.	.	A	.	T	.	C	.	.
H3	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.
H4	.	C	.	.	.	A	.	.	.	A	G	.	.	C	.	G
H5	.	.	.	.	G	.	C	.	.	.	.	.	.	.	.	.
H6	.	C	.	.	.	A	C	.	.	A	.	.	.	C	.	G
H7	G	C	.	.	.	A	C	.	.	A	.	T	.	C	.	G
H8	.	.	A	A	.	A	.	G	G	.	.	.	C	.	T	.

Table 2. Number of found haplotypes

Haplotype	n	sample
H1	3	SR9 SR13 SR10
H2	3	SR8 SR5 SR2
H3	1	SR7
H4	1	SR4
H5	1	SR3
H6	1	SR14
H7	1	SR12
H8	1	SR1

Median-joining network (Fig. 1) is constructed to identify the genealogical connection among the 8 identified CR-1 mtDNA haplotypes. H1 and H8 represent the most distant neighbor haplotypes (7 mutation steps), followed by H6 and H3. Obtained MJ network confirms the great genetic diversity and indicates certain structuring of roe deer population, but conclusions cannot be driven due to low number of samples analysed.

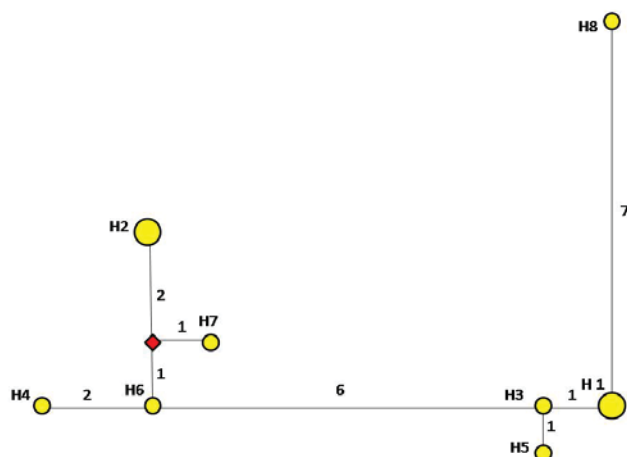


Figure 1: Median-joining network of eight identified mtDNA haplotypes. Size of the circle is proportional to the relative frequency of the haplotype. Number between two adjacent haplotypes indicates the number of mutational steps between them.

Conclusion

In the dataset of 12 roe deer CR-1 mtDNA sequences we have identified 8 haplotypes. Six haplotypes were unique, while two (H1 and H2) had a higher frequency. The haplotype diversity was high. Tests of neutrality and mismatch distribution analysis supported past demographic expansion. Although the small number of specimens was analyzed, we confirmed the high genetic diversity in *Capreolus capreolus* L. populations from Vojvodina, which is characteristic of the Western Balkan countries.

Acknowledgment

This work was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Grant No. 43002 and the Provincial Secretariat for Science and Technological Development, Grant No. 114-457-2173/2011-01 and Provincial Secretariat for Agriculture, Water Management and Forestry Project „Genetic diversity, growth, trophy structure and spatial distribution of roe deer populations in hunting grounds in Vojvodina Province”, Grant No. 104-401-4099/2013-07-2b-1.

References

1. Baker K, Karis, Helen. 2011. Population genetic history of the British roe deer (*Capreolus capreolus*) and its implications for diversity and fitness. Durham theses, Durham University. Available at Durham E-Theses Online: <http://etheses.dur.ac.uk/897/>.
2. Coulon A, Guillot G, Cosson JF, Angibault JMA, Aulagnier S, Cargnelutti B, Galan M, Hewison AJM. 2006. Molecular Ecology 15: 1669-1679.
3. Fu YX. 1997. Statistical tests of neutrality against population growth, hitchhiking and background selection. Genetics 147: 915-925.
4. Galan M, Cosson JF, Aulagnier S, Maillard JC, Thévenon S, Hewison AJM. 2003. Cross-amplification tests of ungulate primers in roe deer (*Capreolus capreolus*) to develop a multiplex panel of 12 microsatellite loci. Molecular Ecology Notes 3:142-146.
5. Hall TA. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic Acids Symposium Series 41: 95-98.
6. Hartl GB, Reimoser F, Willing R, Köller J. 1991. Genetic variability and differentiation in roe deer (*Capreolus Capreolus*, L.) of Central Europe. Genet Sel Evol 23: 281-299.
7. Librado P, Rozas J. 2009. DnaSP v5: A software for comprehensive analysis of DNA polymorphism data. Bioinformatics. 25: 1451-1452.
8. Lorenzini R and Lovari S. 2006. Genetic diversity and phylogeography of the European roe deer: the refuge area theory revisited. Biological Journal of the Linnean Society 88: 85-100.
9. Randi e, Alves PC, Carranza J, Milošević-Zlatanović S, Sfougaris A, Mucci N. 2004. Phylogeography of roe deer (*Capreolus Capreolus*) populations: the effects of historical genetic subdivisions and recent nonequilibrium dynamics. Mol. Ecology 13: 3071-3083.
10. Randi E, Pierpaoli M, Danilkin A. 1998. Mitochondrial DNA polymorphism in populations of Siberian and European roe deer (*Capreolus Pygargus* and *C. capreolus*). Heredity 80: 429-437.
11. Royo LJ, Pajares G, Álvarez I, Fernández I, Goyache F. 2007. Genetic variability and differentiation in Spanish roe deer (*Capreolus Capreolus*): A phylogeographic reassessment within the European framework. Molecular Phylogenetics and Evolution 42: 47-61.
12. Sommer RS, Fahlke JM, Schmölcke U, Benecke N, Zachos FE. 2009. Quaternary history of the European roe deer *Capreolus capreolus*. Mammal Rev. 39: 1-16.
13. Tajima F. 1989. Statistical method for testing the neutral mutation hypothesis by DNA polymorphism. Genetics. 123: 585-595.
14. Vor T, Kiffner C, Hagedorn P, Niedrig M, Ferdinand R. 2010. Tick burden on European roe deer (*Capreolus Capreolus*). Exp Appl Acarol. 51: 405-417.

COMPARATIVE ANALYSIS OF WILD BOAR AND DOMESTIC PIG POPULATIONS BASED ON MICROSATELLITES DATA

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Summary: Wild boar is very important and one of the most abundant game species in hunting areas of Vojvodina. Agriculture and human-induced habitat transformations, game practices and translocations deeply affected the recent demographic trends and the genetic composition of wild boar populations in Europe. Genetic characterization of different wild boar populations can provide data useful for monitoring, identification and traceability of animals. A particular problem related to wild boar is the need to avoid or monitoring genetic introgression from domestic pigs. This is important as wild boars can crossbred with domestic pigs producing fertile hybrids. The main aim of this study was to estimate genetic variability of wild boar populations in Vojvodina and to compare it with domestic pig populations, using eleven tetranucleotide microsatellite markers. Total number of 63 wild boars from Vojvodina and 33 domestic pigs were collected. Multiplex PCR amplification of 11 tetranucleotide microsatellites was carried out. Genetic variability and population structure was assessed using standard population-genetic softwares. Bayesian cluster analysis implemented in STRUCTURE clearly separated wild boars from domestic pigs. Only one wild boar sample appeared to be hybrid between wild boar and domestic pig. In the analyzed sample of wild boars from Vojvodina, total number of 117 alleles was revealed, with a mean number of 10.6 alleles per locus, while in domestic pigs total number of alleles was 137, with a mean number of alleles per locus 12.45. The number of private alleles for wild boar populations was 40, while 61 private alleles were observed in domestic pigs. Average observed and expected heterozygosity values in wild boars were 0.69 and 0.79, while observed heterozygosity in domestic pigs was 0.67 and expected heterozygosity was 0.82. High genetic variability was observed in both wild boars and domestic pigs. Our results point out that management strategy should be narrowed to preserve observed level of genetic variability in both wild and domestic forms. Moreover, management of wild boar populations should be focused on preventing uncontrolled translocations and crossbred with domestic pigs.

Key words: wild boar, domestic pig, microsatellite variability, Vojvodina

Introduction

The wild boar is native and one of the most abundant large game species that play a key role on the agricultural ecosystems and have an important economic impact in hunting areas of Vojvodina. Over the past two decade, tremendous progress has been made in mapping and characterizing the swine genome (Ellegren et al., 1994; Rohrer et al., 1996; Hawken et al., 1999; Rink et al., 2002; Chen et al., 2007; Jiang & Rothschild, 2007). Despite the numerous literature data on genetic variability in the domestic pig, little is known about genetic diversity and structure of wild boar populations. Demographic trends and the genetic composition of wild boar populations in Europe have been affected by human-induced habitat transformations, game practices and agricultural development (Randi, 2005). On the other hand, the present-day genetic diversity and geographical distribution of wild boars has been also shaped

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by Quaternary climatic fluctuations and ice ages (Scandura et al., 2008; Alexandri et al., 2012; Kusza et al., 2014).

There is nowadays strong evidence that the southern European peninsulas might acted as refugia during the glacial periods (Hewitt, 2004; Scandura et al., 2008; Stamatis et al., 2009; Alexandri et al., 2012). Among these, major geographic barriers exist separating Iberia and the Italian peninsula from continental Europe, namely the Pyrenees and the Alps. Such a barrier does not exist in the Balkans and it is therefore reasonable to think that the Balkans represent maybe the most important genetic pool of game species that recolonized central and northern Europe after the LGM, such as the wild boar (Hewitt, 1999; Scandura et al., 2008; Alexandri et al., 2012). Wild boars captured or hunted in the Balkans are commercialized throughout Europe as live animals or meat. Management of genetic resources of this species needs a detailed description of the variability represented by different populations and integration of these data with their dynamics for a fruitful economic exploitation and sustainability. In addition, genetic characterization of different wild boar populations in Europe can provide data useful for monitoring, identification and traceability of animals or meat, which makes it relevant in the forensic context. A particular problem related to wild boar is the need to avoid or monitoring genetic introgression from domestic pigs. This is important as wild boars can crossbred with domestic pigs producing fertile hybrids, which presents both economical and ecological risks. Contact among wild and domestic forms of this species poses an additional threat on public health since wild boar is a well-known tuberculosis vector. The main aim of this study was to estimate genetic variability of wild boar populations in Vojvodina and to compare it with domestic pig populations, using eleven tetranucleotide microsatellite markers.

Material and Methods

Muscle tissue samples of 63 wild boars were collected in regular hunts from 14 different localities across Vojvodina. Whole blood samples were collected from 33 domestic pigs. Total DNA was extracted using Proteinase K digestion followed by standard phenol-chloroform-isoamylalcohol extraction (Sambrook and Russel, 2001). Multiplex PCR amplification of 11 tetranucleotide microsatellites was carried out using Animaltype Pig PCR Amplification Kit (Biotype AG, Dresden, Germany) following the manufacturer recommendations. Typing was done by capillary electrophoresis on the ABI3730xl Genetic Analyzer (Applied Biosystem). The products of fragment analysis of these 11 microsatellites were analyzed using Peak Scanner Software v1.0 (Applied Biosystem) in comparison to allelic ladder and a control DNA sample (DL157) of known genotype provided with the kit.

In order to infer the existence of population structuring and reveal potential hybrids between wild boars and domestic pigs, Bayesian cluster analysis implemented in STRUCTURE 2.3.3 (Pritchard et al., 2000) was performed. Detection of migrants and hybrids between wild and domestic forms was performed using computer package NEWHYBRIDS 1.0 (Anderson and Thompson 2002).. ARLEQUIN v3.5 (Excoffier and Lischer 2010) was employed to estimate allele frequencies and gene diversity in wild boars and domestic pigs.

Results and Discussion

In order to asses genetic diversity of wild boars from hunting grounds in Vojvodina and compare with domestic pig breeds, we analyzed 11 tetranucleotide microsatellites in 63 wild boars and 33 domestic pigs. All markers showed high level of polymorphism in both wild and domestic forms, and in the wild boars total number of 117 alleles was revealed, with a mean number of 10.6 alleles per locus, while in domestic pigs total number of alleles was 137, with a mean number of alleles per locus 12.45. The number of private alleles for wild boar populations was 40, while 61 private alleles were observed in domestic pigs. Lowest number of observed alleles per locus was observed in locus SBH19 in wild boars (N=5) and locus SBH13 in domestic pigs (N=9), while highest number of alleles per locus was found in locus SBH20 in wild boar samples (N=19) and locus SBH18 in domestic pigs (N=16). Average observed and expected heterozygosity values in wild boars were 0.69 and 0.79, while observed heterozygosity in domestic pigs was 0.67 and expected heterozygosity was 0.82 (Tab. 1). According to the number of observed alleles, higher genetic variability was revealed in domestic pig comparing to wild boars, while

with the calculation of observed and expected heterozygosity similar values of genetic variability for wild boars and domestic pigs were found.

Table 1. Comparison of basic genetic indices observed in wild boars and domestic pigs

Locus	Wild boar				Domestic pig			
	A	Apriv	H _O	H _E	A	Apriv	H _O	H _E
SBH2	11	6	0.59	0.61	10	5	0.55	0.75
SBH18	9	2	0.79	0.83	16	9	0.85	0.87
SBH4	11	1	0.70	0.77	15	5	0.85	0.86
S0655	9	4	0.79	0.78	11	6	0.62	0.81
SBH20	19	11	0.84	0.91	14	6	0.82	0.80
SBH1	9	3	0.75	0.82	13	7	0.61	0.82
SBH10	15	6	0.81	0.88	14	6	0.76	0.84
SBH13	8	2	0.52	0.61	9	3	0.73	0.81
387A12F	13	3	0.73	0.81	15	5	0.79	0.88
SBH22	8	2	0.35	0.65	10	4	0.61	0.81
SBH19	5	0	0.67	0.71	10	5	0.24	0.74
Total	117	40	-	-	137	61	-	-
Average	10.6	3.64	0.69	0.76	12.45	5.55	0.67	0.82

A – number of alleles per locus; Apriv - number of private alleles; H_O – observed heterozygosity; H_E – expected heterozygosity

Bayesian cluster analysis implemented in STRUCTURE clearly separated wild boars from domestic pigs (Fig. 1). Only one wild boar sample appeared to be clear hybrid between wild boar and domestic pig and one more wild boar sample showed the possession of domestic pig genome. Software NEWHYBRIDS was used for pairwise analysis of wild boar and domestic pigs in order to detect hybrids. Results of this analysis fully corroborated to STRUCTURE analysis, since it was shown the presence of two F1 hybrids in the analyzed sample of wild boars (Fig. 2).

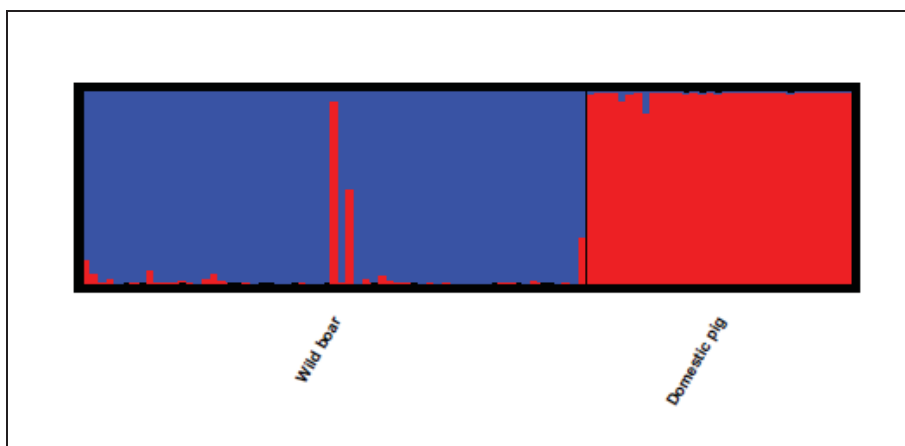


Figure 1. Illustrative interpretation of STRUCTURE analysis for K=2

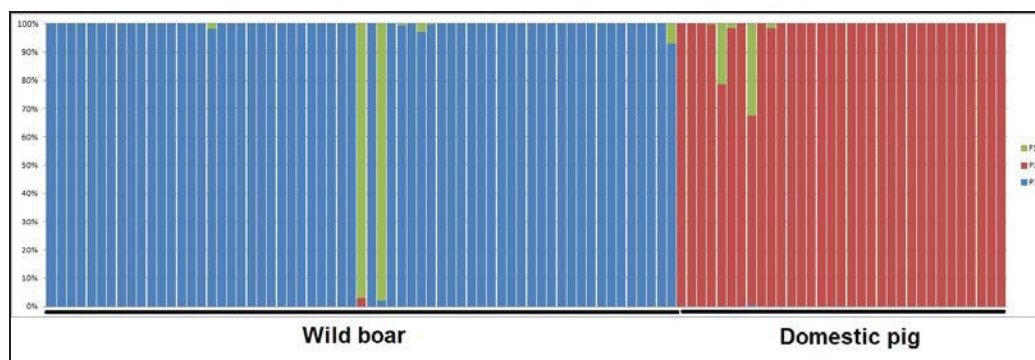


Figure 2. Results from the simulation considering two parental (P1 & P2) and one hybrid classes (F1), for pairwise analysis of wild boars and domestic pigs, using NEWHYBRIDS. Each individual is represented by a vertical bar. Likelihoods of assignment to parental and F1 classes are plotted in different colours. Horizontal bars represent a priori geographic origin.

Since the wild boar is the game species that provides great economic income to hunters and hunting associations and hunting grounds in Vojvodina Province are one of the most important in the region, it is very important to consider the implications of obtained results for the sustainable management of this species. Obtained results point out that management strategies of wild boar populations in Vojvodina should be narrowed to preserve observed level of genetic variability and on prevention of uncontrolled translocations and crossbreeding with domestic pigs.

Conclusion

The recent expansion of wild boar populations in Serbia raised concern about the investigation of genetic diversity and structure of wild boar populations in order to develop adequate management strategies. Since wild boars can crossbred with domestic pigs producing fertile hybrids, it is very important to examine percentage of hybridization. In this study high genetic variability was observed in both wild boars and domestic pigs. In the analysis of 63 wild boars, only two was shown to be hybrids between wild boars and domestic pigs. This result point out that for sustainable management of wild boars in hunting grounds in Vojvodina Province contacts of wild boars and domestic pigs should be strictly controlled in order to prevent introgression of domestic pig genes to wild boars and to maintain registered high genetic diversity.

Acknowledgment

This work was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Grant No. 43002 and the Provincial Secretariat for Science and Technological Development, Grant No. 114-457-2173/2011-01 and Provincial Secretariat for Agriculture, Water Management and Forestry Project „Genetic diversity of wild boar populations in hunting grounds in Vojvodina Province with assessment of levels of hybridization between wild boars and domestic pigs”, Grant No. 104-401-4137/2013-07-2b-1.

References

1. Alexandri, P., Triantafyllidis, A., Papakostas, S., Chatzinikos, E., Platis, P., Papageorgiou, N., Larson, G., Abatzopoulos, T. J., Triantaphyllidis, C., (2012), The Balkans and the colonization of Europe: the post-glacial range expansion of the wild boar, *Sus scrofa*. Journal of Biogeography, 39, 713-723.
2. Anderson, E.C., Thompson, E.A., (2002), A model-based method for identifying species hybrids using multilocus genetic data. Genetics, 160, 1217-1229.
3. Chen, K., Baxter, T., Muir, W.M., Groenen, M.A., Schook, L.B., (2007), Genetic resources, genome mapping and evolutionary genomic of the pig (*Sus scrofa*). International Journal of Biological Sciences 3(3): 153-165.

4. Ellegren, H., Chowdhary, B.P., Johansson, M., Marklund, L., Fredholm, M., Gustavsson, I., Andersson, L., (1994), A primary linkage map of the porcine genome reveals a low rate of genetic recombination. *Genetics* 137:1089-1100.
5. Excoffier, L., Lischer H.E.L., (2010), Arlequin suite ver 3.5: A new series of programs to perform population genetics analyses under Linux and Windows. *Molecular Ecology Resources*, 10, 564-567.
6. Hawken, R.J., Murtaugh, J., Flickinger, G.H., Yerle, M., Robic, A., Milan, D., Gellin, J., Beattie, C.W., Schook, L.B., Alexander, L.J., (1999), A first generation porcine whole-genome radiation hybrid map. *Mammalian Genome* 10:824-830.
7. Hewitt, G.M., (1999), Post-glacial recolonization of Europe. *Biological Journal of the Linnean Society*, 68, 87–112.
8. Hewitt, G.M., (2004), Genetic consequences of climatic oscillations in the Quaternary. *Philosophical Transactions Royal Society London B*, 359, 183-195.
9. Jiang, Z., Rothschild, M.F., (2007), Swine genome science comes of age. *International Journal of Biological Sciences* 3(3): 129-131.
10. Kusza, S., Podgórski, T., Scandura, M., Borowik, T., Jávora, A., Sidorovich, V.E., Bunevich, A.N., Kolesnikov, M. & Jędrezejewska B., (2014), Contemporary genetic structure, phylogeography and past demographic processes of wild boar *Sus scrofa* population in Central and Eastern Europe. *PlosONE*, 9 (3), e91401.
11. Pritchard, J. K., Stephens, M. & Donnelly, P., (2000), Inference of population structure using multilocus genotype data. *Genetics*, 155, 945–959.
12. Randi, E., (2005), Management of wild ungulate populations in Italy: captive-breeding, hybridization and genetic consequences of translocations. *Veterinary Research Communications*, 29 (Suppl. 2), 71–75.
13. Rink, A., Santchi, E.M., Eyer, K.M., Roelofs, B., Hess, M., Godfrey, M., Karajusuf, E.K., Yerle, M., Milan, D., Beattie, C.W., (2002), A first-generation EST RH comparative map of the porcine and human genome. *Mammalian Genome* 13:578-587.
14. Rohrer, G.A., Alexander, L.J., Hu, Z., Smith, T.P., Keele, J.W., Beattie, C.W., (1996), A comprehensive map of the porcine genome. *Genome Research* 6: 371–391.
15. Sambrook, J.F., Russel, D.W., (2001), *Molecular Cloning: A laboratory Manual*. 3rd Ed., Cold Spring Harbor, Laboratory Press, USA.
16. Scandura, M., Iacolina, L., Crestanello, B., Pecchioli, E., Benedetto, M.F., Russo, V., Davoli, R., Apollonio, M. & Bertorelle, G., (2008), Ancient vs. recent processes as factors shaping genetic variation of the European wild boar: are the effects of the last glaciation still detectable. *Molecular Ecology*, 17, 1745-1762.
17. Stamatis, C., Suchentrunk, F., Moutou, K.A., Giacometti, M., Haerer, G., Djan, M., Vapa, Lj., Vukovic, M., Tvrtkovic, N., Sert, H., Alves, P.C., Mamuris, Z., (2009), Phylogeography of the brown hare (*Lepus europaeus*) in Europe: a legacy of south-eastern Mediterranean refugia? *Journal of Biogeography*, 36, 515–528.

GENETIC VARIABILITY OF GREY WOLF (*Canis lupus*) POPULATION IN BOSNIA AND HERZEGOVINA

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Brief Introduction: Previous analyses of genetic diversity in grey wolf populations from Europe showed that grey wolves from the Balkans retained high portion of variability comparing to other European grey wolf populations. The main goal of this research was to determine genetic variability of grey wolf population from Bosnia and Herzegovina based on mtDNA control region sequence variability.

Material and Methods: Muscle tissue samples of 17 grey wolf individuals were collected. Total DNA was extracted and partial fragment of mitochondrial control region was amplified and sequenced.

Results: The final length of sequences in the dataset was 283bp, among which 10 were variable positions (9 parsimony informative sites and 1 singleton variable site). In total, four haplotypes were detected in grey wolf population from Bosnia and Herzegovina. Haplotype diversity was $h=0.625\pm0.083$, nucleotide diversity, $\pi=0.012$, while average number of nucleotide differences was $k=3.515$. One haplotype showed high frequency (52.9%), one intermediate frequency (35.3%) and two haplotypes were rare and detected only per one individual (5.9% each). Mismatch distribution analysis showed statistically significant deviation from the null hypothesis that the observed data fit the sudden expansion model ($Ssd=0.136$; $p=0.03$). Fu's F_s and Tajima's D tests of neutrality showed positive, although not statistically significant values. Multimodal mismatch distribution and positive values of neutrality tests may indicate past population size decline.

Conclusion: We have found high genetic variability within analysed grey wolf population, as expected for the Dinaric-Balkan grey wolf populations, as compared with other European wolf populations. Detection of present genetic diversity and demographic history is important for determination of population structure and sustainable management of the population.

Key words: grey wolf, genetic variability, mtDNA, Bosnia and Herzegovina

Introduction

The grey wolf (*Canis lupus*) is a species that was very abundant and widely distributed in Europe until the end of the 19th and beginning of the 20th century, when the decline of its populations was observed (Boitani, 2000). The main reasons for grey wolf populations decline in Europe are widespread destruction of its habitats, human prosecution and decreases in natural prey (Delibes, 1990; Randi et al., 2000; Randi, 2011). Delibes (1990) stated that during the population decline period in Europe, two isolated populations survived, one in Italy and one in Iberia, while larger populations remained in the Balkans and Eastern Europe (Boitani, 2000; Lucchini et al., 2004; Gomerčić et al., 2010). Some of the Balkans countries have protected the grey wolf species, but Bosnia and Herzegovina is not one of them. The available data estimate approximately 400 individuals in Bosnia&Herzegovina (Boitani, 2000; Milenković et al., 2007), and according to the Association of hunting organization in Bosnia and Herzegovina, there are around 350 wolves (www.slobih.ba). Distribution of the grey wolf populations

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in Bosnia and Herzegovina is very wide and includes karstic fields and mountains (Sofradžija and Muzaferović, 2007) at the border with Croatia, Montenegro and the Dinaric region. Continuous distribution and documented gene flow between wolves from Bosnia, Croatia and Slovenia was reported and they were grouped in large Dinaric-Balkan population (Štrbenac et al., 2005, 2008) together with populations from Serbia, Montenegro, Albania and FYR Macedonia (Gomerčić et al., 2010).

The Balkan grey wolf population represents the border between populations from Eastern and Western Europe (Djan et al., 2014) and genetic substructuring on north-south axis has been observed. The first data on genetic diversity of Dinaric-Balkan grey wolf population showed high genetic diversity and differentiation to “western” and “eastern” subpopulations with different demographic histories (Djan et al., 2014).

The aim of this study was to detect level of genetic diversity in grey wolf population in Bosnia and Herzegovina and to determine genetic structure, as well as to find evidence of possible population expansion and/or bottleneck, using analysis of sequence variability of mtDNA control region.

Material and Methods

Material

Genetic variability analysis of the grey wolf population in Bosnia and Herzegovina included 17 muscle tissue samples, collected during legal hunts at several localities (Fig. 1). Tissue samples were stored at -20°C prior to analysis.



Figure 1. Geographic positions of sampling localities.

Molecular analysis

Extraction of total mtDNA from each muscle tissue sample was done using phenol chloroform extraction (Sambrook and Russel, 2001). Partial fragment of mtDNA control region was amplified using CR1 and CR2R primers (Palomares et al., 2002) in a total reaction volume of 25µl. Reaction mixture for PCR contained 0.2mM dNTPs, 0.1 µM of each primer, 2.5mM MgCl₂, 1U Taq polymerase and 1xreaction buffer. PCR amplification was performed by following conditions: denaturation at 95°C for 5 min; 35 cycles of amplification (each cycle begins at 94°C for 40s; 55°C for 50s and 72°C

for 1 min) and final extension at 72°C for 10min. The PCR products were purified using Exo-Sap protocol. Sequencing was conducted with an ABI3730xl genetic analyzer (Applied Biosystems).

Data analyses

Sequence alignment was performed in BioEdit software (Hall 1999), and final adjustments were done by eye. Our dataset consisted of 17 CR-1 mtDNA sequences with final length 283bp. DNASP (Librado and Rozas 2009) was used for calculations of basic parameters of genetic diversity (haplotype diversity, nucleotide diversity, average number of pairwise differences) and mismatch distribution analysis and neutrality tests (Fu's F_s and Tajima's D) were performed in same program.

In order to test hypothesis of population structure, sample was divided to „west” and „east” subpopulations and AMOVA analysis was done in Arlequin (Excoffier and Lischer 2010), together with mismatch distribution analyses for both subpopulations and total population. Median Joining network was constructed in order to visualize mutational pathways among found haplotypes using Network 4.6.0.0 software (<http://www.fluxus-engineering.com/sharenetwork.htm>).

Results

Amplification of the grey wolf mtDNA control region from Bosnia and Herzegovina was successful for all 17 samples. Analysis of 17 mtDNA sequences, with a total length of 283bp, revealed presence of 10 variable positions (9 parsimony informative sites and 1 singleton variable site) and 4 haplotypes (Table 1). Haplotype diversity was 0.625 ± 0.083 , nucleotide diversity was 0.012, and average number of nucleotide differences was 3.515. One haplotype showed high frequency (52.9%), one intermediate (35.3%) and two haplotypes were rare and detected only per one individual (5.9% each).

Table 1. Control region mtDNA haplotypes of grey wolf from the territory of Bosnia and Herzegovina with associated variable positions.

Haplo types	Variable positions										N	%
	47	66	93	135	151	161	165	176	183	192		
H1	T	T	G	C	T	C	T	T	G	A	9	0.529
H2	.	.	A	T	.	T	C	.	A	.	6	0.352
H3	C	C	A	C	C	C	T	C	.	G	1	0.058
H4	T	C	A	C	C	.	.	C	.	G	1	0.058

N- number of individuals sharing the same haplotype. %- percentage of total number of haplotypes.

Calculated parameters of genetic diversity show high genetic variability of analysed grey wolf population, which was expected, since high genetic diversity in grey wolf populations from the Balkans was reported before (Gomerčić et al., 2010; Fabri et al., 2013; Djan et al., 2014). The grey wolf populations from the Balkans, generally, have higher genetic variability in comparison to other European populations, most probably due to moderate size fluctuations in the past as reported for Bulgaria (Randi et al., 2000) and Croatia (Gomerčić et al., 2010; Fabbri et al., 2013). The high genetic diversity was also revealed using microsatellites (Lucchini et al., 2004; Moura et al., 2013).

The mismatch distribution analysis showed statistically significant deviation from the null hypothesis corresponding to the model of the rapid expansion ($S_{sd}=0.136$; $p=0.03$). Fu's F_s and Tajima's D tests of neutrality showed positive, but statistically insignificant values. Observed multimodal mismatch distribution and positive values of neutrality tests showed that no population expansion is present, even though it might be that recent population decline has happened. The reflection of recent population size decline to population genetic variability and structure was previously reported by Fabbri et al. (2013) and Djan et al. (2014).

AMOVA analysis showed no significant differentiation between presumed „west” and „east” subpopulations, indicating that no genetic structure is present in grey wolves from Bosnia&Herzegovina. This result, however, should be confirmed in further analyses, since low number of individuals is analysed in this research.

Constructed median-joining network showed that number of mutational steps among haplotypes vary between 1 and 5 (Fig. 2)

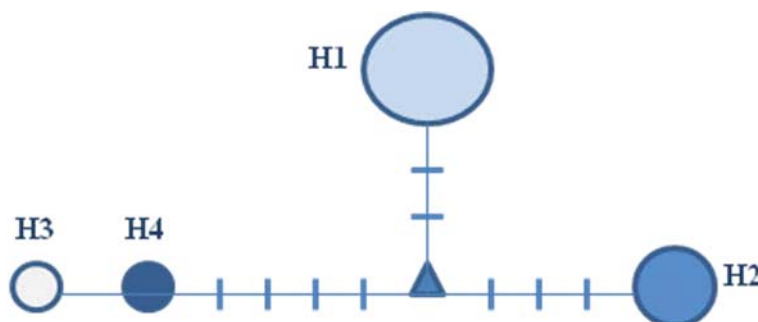


Figure 2. Median-joining network of 4 determined mtDNA control region haplotypes. Circle sizes correspond to the frequencies of the haplotypes.

Conclusion

Conducted research indicates high genetic variability within analysed grey wolf population, as expected for the Dinaric-Balkan grey wolf populations, as compared with other European wolf populations. Detection of present genetic diversity and demographic history is important for determination of population structure and sustainable management of the population.

Acknowledgement

This research was partially supported by Ministry of Education, Science and Technological Development of Republic of Serbia, Grant No. 43002.

References

1. Boitani, L., (2000.) Action Plan for the conservation of the wolves (*Canis lupus*) in Europe. Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). Nature and environment, No. 113. Council of Europe Publishing, Strasbourg.
2. Delibes, M., (1990.) Status and conservation needs of the wolf (*Canis lupus*) in the Council of Europe member states. Nature and Environment Series, No.47. Council of Europe, Strasbourg, France.
3. Djan, M., Maletić, V., Trbojević, I., Popović, D., Veličković, N., Burazerović, J., Čirović, D. (2014.) Genetic diversity and structuring of the grey wolf population from the Central Balkans based on mitochondrial DNA variation. Mammalian Biology - Zeitschrift für Säugetierkunde, Volume 79, Issue 4, June 2014, Pages 277-282.
4. Excoffier, L., Lischer, H.E.L., (2010.) Arlequin suite ver 3.5: a new series of programs to perform population genetics analyses under Linux and Windows. Mol. Ecol. Resour. 10, 564–567.
5. Fabbri, E., Caniglia, R., Kusak, J., Galov, T., Gomerčić, T., Arbanasić, H., Huber, D., Randi, E., (2013.) Genetic structure of expanding wolf (*Canis lupus*) populations in Italy and Croatia, and the early steps of the recolonization of the Eastern Alps. Mamm. Biol., <http://dx.doi.org/10.1016/j.mambio.2013.10.002>.
6. Gomerčić, T., Sindičić, M., Galov, A., Arbanasić, H., Kusak, J., Kocijan, I., Đuras Gomerčić, M., Huber, Đ., (2010.) High genetic variability of the grey wolf (*Canis lupus* L.) population from Croatia as revealed by mitochondrial DNA control region sequences. Zool. Stud. 49 (6), 816–823.
7. Hall, T.A., (1999.) BioEdit: a user-friendly biological sequence alignment editor and analysis program for windows 95/98/NT. Nucleic Acids Symp. Ser. 41, 95–98.
8. Librado, P., Rozas, J., (2009.) DnaSP v5: a software for comprehensive analysis of DNA polymorphism data. Bioinformatics 25, 1451–1452.
9. Lucchini, V., Galov, A., Randi, E., (2004.) Evidence of genetic distinction and long-term population decline in wolves (*Canis lupus*) in the Italian Apennines. Mol. Ecol. 13, 523–536.

10. Milenković, M., Paunović, M., Ćirović, D., (2007.) Action plan for wolf *Canis lupus L.*, 1758 conservation in Serbia. Phase I – strategic plan. Institute for Biological Research Siniša Stanković, Belgrade, Ministry of Environmental Protection Republic of Serbia. Project report.
11. Moura, A.E., Tsingarska, E., Dabrowski, M.J., Czarnomska, S.D., Jedrzejewska, B., Pilot, M., (2013.) Unregulated hunting and genetic recovery from a severe population decline: the cautionary case of Bulgarian wolves. *Conserv. Genet.*, <http://dx.doi.org/10.1007/s10592-013-0547-y>.
12. Palomares, F., Godoy, J.A., Piriz, A., O'Brien, S.J., Johnson, W.E., (2002.) Fecal genetic analysis to determine the presence and distribution of elusive carnivores: design and feasibility for the Iberian lynx. *Mol. Ecol.* 11, 2171–2182.
13. Randi, E., Lucchini, V., Christensen, M.F., Mucci, N., Funk, S.M., Dolf, G., Loeschcke, V., 2000. Mitochondrial DNA variability in Italian and East European wolves: detecting the consequences of small population size and hybridization. *Conserv. Biol.* 14, 464–473.
14. Randi, E., (2011.) Genetic and conservation of wolve *Canis lupus* in Europe. *Mammal. Rev.* 41 (2), 99–111.
15. Sambrook, J.F., Russel, D.W., (2001.) *Molecular Cloning: A Laboratory Manual*, 3rd ed. Cold Spring Harbour Laboratory Press, USA.
16. Sofradžija, A., Muzaferović, Š., (2007.) *Biodiverzitet sisara Bosne i Hercegovine*, katalog. INGEB, Sarajevo.
17. Štrbenac, A., Huber, Đ., Kusak, J., Majić-Skrbinšek, A., Frković, A., Štahan, Ž., Jeremić-Martinko, J., Desnica, S., Štrbenac, P., (2005.) *Wolf Management Plan for the Republic Croatia*. State Institute for Nature Protection, Zagreb, Croatia.
18. Štrbenac, A., Huber, Đ., Kusak, J., Oković, P., Sindičić, M., Jeremić, J., Frković, A., Gomerčić, T., (2008.) *Large carnivore conservation in Croatia bulletin*. State Institute for Nature Protection, Zagreb, Croatia.
19. www.slobih.ba
20. <http://www.fluxus-engineering.com/sharenet.htm>

ANTIBODIES TO SELECTED VIRAL DISEASE AGENTS IN HUNTED WILD BOARS IN VOJVODINA REGION

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Summary: The aim of the current study was to investigate the presence of antibodies to selected viral disease agents (PRRSV, PPV and CSFV) in hunted wild boars in Vojvodina region. Blood samples from 300 hunted wild boars from hunting ground were collected during the hunting season from October 2011 until March 2012. Presence of anti-PRRSV and anti-CSFV antibodies was determined using a commercially available ELISA test kits while the presence of anti-PPV antibodies was determined using the method of hemagglutination inhibition (HI test). Out of total 300 examined blood samples, in 49.33% antibodies against PPV, 1.33% antibodies against PRRSV and 10.33% antibodies against CSFV was detected. These results, support the hypothesis that wild boar are reservoirs of certain viral infectious agents, but some infections in wild boars originate from domestic swine. 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.

Key words: wild boars, swine viral diseases, Vojvodina

Introduction

Wild boar (*Sus scrofa scrofa*) numbers have dramatically increased over the past 60 years and the species also shows a more widespread distribution (Sedlak et al., 2008; Wu et al., 2011). The increase in population density of wild boar raises concerns regarding the welfare and an increasing prevalence of infectious diseases and parasites (Ruiz-Fons et al., 2008). 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 (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 population (Frölich et al., 2002; Prodanov-Radulović et al., 2013; Ruiz-Fons et al., 2008). Among the agriculturally important pathogens known to be prevalent in wild boars are Classical swine fever virus (CSFV), Pseudorabies virus (PRV), African swine fever virus (ASFV), Porcine circovirus type 2 (PCV2), Porcine reproductive and respiratory syndrome virus (PRRSV) and Porcine parvovirus (PPV) (Albina et al., 2000; Meng et al., 2009; Montagnaro et al., 2006; Kaden et al., 2006; Roic et al., 2012; Ruiz-Fons et al., 2006). 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; Ruiz-Fons et al., 2008).

In our country a certain number of wild boars are reared in controlled and enclosed hunting grounds, while a number of free-ranging populations are mainly unknown. One of the characteristics of outdoor swine production in some regions is raising free-roaming domestic pigs, where they share forest habitat with wild boars (Prodanov-Radulović et al., 2010; Prodanov-Radulović et al., 2013). Contacts between wild boars and domestic pigs kept in outdoor farms may occur occasionally (Albina et al., 2000; Prodanov et al., 2009; Roic et al., 2012; Sedlak et al., 2008). Since both animals have the same susceptibility to various infections including CSFV, PRRSV and PPV, there is a major concern to monitor the epidemiological situation of wild boars especially when control measures in domestic pigs

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Original scientific paper

UDC: 639.111.1

are implemented (Lupulović et al., 2007; Montagnaro et al., 2010; Roic et al., 2012; Vengust et al., 2006). 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 (Lupulović et al., 2007; Prodanov-Radulović et al., 2010; Prodanov-Radulović et al., 2013)..

The objective of our study was to conduct a serologic survey of the hunted wild boars in Vojvodina region, focusing on selected viral diseases (CSFV, PRRSV, PPV) that are epidemiologically and economically important to the health of both wild boar and domestic swine populations.

Material and Methods

Sera samples

Blood samples from 300 hunted wild boars from hunting ground of Vojvodina were collected during the hunting season from October 2011 until March 2012. The samples were collected on shot wild boars by the veterinarians or by hunters. Hunters were previously trained to collect the blood from the heart and asked for doing the sample as soon as possible after death. Blood samples were sent to the Scientific Veterinary Institute "Novi Sad" either immediately or after storage at 48 °C for few days. In the laboratories, the samples were centrifuged and only sera of minimal quality (limited hemolysis and absence of protein denaturation) were selected for serology. All sera were collected under the National Classical Swine Fever Virus Surveillance Program and, therefore, no age or sex data were available for these animals.

Serology testing

Enzyme-linked immunosorbent assay (ELISA)

Commercially available ELISA test kit-INGEZIM PRRS Universal (Ingenasa, Madrid, Spain) was used for detecting anti-PRRSV antibodies in serum samples. The ELISA was performed according to the manufacturer's instructions, and in the ISO/IEC 17025:2005 standard accredited laboratory. This kit is based on an indirect enzymatic immunoassay (Indirect ELISA). The reaction was read at a wavelength of 405 nm, and specific antibody levels were expressed as optical density values (OD). The results were expressed as positive or negative based on producer's recommended cut off value.

For CSFV serum antibody detection the commercial indirect immunoenzyme test (ELISA) kit (Classical Swine Fever Virus Antibody Test Kit, HerdChek CSFVAb, IDEXX Laboratories, USA) was used according to manufacturer's instruction.

Haemagglutination inhibition test (HI test) for PPV

The blood serum samples to be tested for PPV antibodies were heat-inactivated at 56 °C for 30 min. Haemagglutination inhibition (HI) test was carried out on 96 – U-bottom plates. Two-fold dilution of the treated serum were made in 25 µl volumes of PBS (pH 7.2), and 25 µl of viral suspension containing 4 haemagglutinating units of PPV (strain TEEN, American Bioresearch, USA) was added to each dilution. After incubating for 1 h at 37 °C, 50 µl of 0.6 % suspension of guinea pig erythrocytes was added and the plates were incubated at room temperature for additional 1-1.5 h. Appropriate serum, virus and erythrocytes controls were added to the test. The HI titer of anti-PPV antibodies was expressed as the reciprocal value of the highest sera dilution at which haemagglutination was inhibited. A wild boar was considered to be infected with HI titers higher than 1:256. Wild boars with titers equal to or lower than 1:256 were considered to be non-infected (Huysman et al. 1992; Lupulović et al., 2007; Sorensen et al. 1988).

Results

In cooperation with the hunting societies and local veterinary service gathering of sera samples of hunted wild boars was organized from six districts in Vojvodina (Severnobački, Zapadnobački, Južnobački, Sremski, Severnabanatski and Srednjebanatski district). It should be noted that there are many domestic swine herds in the examined area; these are mainly large or medium-sized swine farms. Also, one of the characteristics of Srem district is outdoor swine production i.e. raising free-roaming domestic pigs. It is especially important that the owners of the free-roaming domestic pigs in the same time have backyard pigs (Prodanov et al., 2009). Having in mind that the domestic pigs are raised as free-

roaming animals and the fact that they share the forest habitat with the wild boars, contact between wildlife and domestic livestock can easily occur (Prodanov–Radulović et al., 2013).

Out of 300 sera tested, in total 31 (10.33%) were found positive in the CSFV- ELISA. The positive samples were from 4 different districts in Vojvodina. Clinically, no abnormal mortality has been reported in the analyzed districts. By additional epizootiological 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 (Prodanov et al., 2009). Therefore, we cannot exclude the possibility that vaccinated wild boars released from closed farm systems in the field may have been sampled and detected as positive in our survey. This could explain the presence of antibodies against CSFV in some of examined sera samples. In previous research conducted in 2013, applying reverse transcription-polymerase chain reaction (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., 2013).

Classical swine fever virus is a small single-strand positive-sense RNA virus, which belongs to the genus *Pestivirus* in the family *Flaviviridae* (Le Potier et al., 2006; Meng et al., 2009). 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., 2009; Roic et al., 2012; Rossi et al., 2005; Vengust et al., 2006). Outbreaks are generally self-limiting in most wild boar populations (Rossi et al., 2005) but, in other cases, CSFV circulates for years (Ruiz-Fons et al., 2008). In some European countries, CSFV has been reintroduced periodically into domestic pigs via contact with infected wild boars (Le Potier et al. 2006). Moreover, epidemiological links between CSF virus infections in wild boars and domestic pigs have been repeatedly reported, mainly in Germany (Ruiz-Fons et al., 2008; Kaden et al., 2006). At present, CSF monitoring program in Serbia is primarily focused on the serological investigations of blood samples from hunted wild boar. Sampling is performed randomly based on the density of the wild boar population in different regions (Prodanov –Radulović et al., 2013).

In only 4 out of 300 sera tested were found seropositive in the PRRSV-ELISA. Seropositive boars were essentially detected in Juznobački district where the domestic pig density and PRRSV prevalence are high. Positive results were not obtained elsewhere, which indicates that PRRSV has little or no importance in examined wild boar populations. This finding is similar to reports from Croatia (Roic et al., 2012), but it differs from other European studies (Albina et al., 2000; Montagnaro et al., 2010; Ruiz-Fons et al., 2006). In France, it is considered that PRRSV infection was introduced by movements of domestic pigs. The virus has probably been transmitted to wild boars due to the high infectious pressure existing in domestic pig farms (Albina et al., 2000). Taken together, these results suggest that when PRRSV enters the wild boar population, its subsequent spread is rather limited, probably because the virus is not easily transmitted within a population of low or medium density (Montagnaro et al., 2010; Roic et al., 2012). The contamination of the wild population is not surprising since PRRS virus is known to spread by air. Currently, the transmission of PRRSV from domestic swine to wild boar is more probable than vice versa. There is lack of convincing evidence to suggest that wild boars serve as a reservoir for PRRSV (Meng et al., 2009; Ruiz-Fons et al., 2008). Owing to this fact, further studies aimed at elucidating whether the origin of the detected seropositivity is a true contact with the virus or the result of false positives will be needed (Boadella et al., 2012).

Antibodies against PPV were widely distributed among the wild boar in the present study: 148 (49.33%) of the 300 examined samples tested PPV positive by the HI test. 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 (extensive grazing, especially in Srem district), thus increasing possible contact and transmission of diseases between wild boars and domestic swine (Prodanov et al., 2009; Prodanov-Radulović et al., 2010; Roic et al., 2005). Infections with PPV represent one of the major causes of reproductive failure in domestic pigs in Vojvodina and systematic monitoring and vaccination programs are implemented (Lupulović et al., 2007). The high prevalence of PPV antibody suggests this virus is endemic in our wild boar populations. However, virus transmission between wild boars and domestic pigs could occur in both directions when contact between these two species occur (Roic et al., 2012).

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In Europe, PPV is highly prevalent in wild boars, with an incidence ranging from 14 to 57 % (Ruiz-Fons et al. 2006). Our results generally correspond to previous findings in Croatia (Roic et al., 2005) and in other European countries (Ruiz-Fons et al., 2006; Vengust et al., 2006), except Italy, where low prevalence of antibody to PPV was reported (Montagnaro et al., 2010). The effect of PPV infection on the health status of wild boars appears to be minimal and subclinical, although it has been reported that PPV infection has a negative effect on the ovulation rate of female wild boars (Ruiz-Fons et al. 2006).

The obtained serological results suggest that wild boars have direct or indirect contact with domestic pigs, which would facilitate transmission of pathogens. The serological survey on shot wild boars presented in this paper relies on one hunting season and only 300 sera samples. Because of relative low amount of serology performed throughout the study, one can identify two limits in this survey. The first limit is the low number of sera analyzed. Therefore, a sample size much larger than the one used in this study is required to estimate a prevalence of infections. A second limit is due to the fact that sera were not collected on a random but rather on a voluntary basis. For instance, in some districts, only few wild boars were sampled, whereas the population is quite important. On the other hand, the results obtained for CSF and PPV serology suggests that this monitoring gives, however, a good indication on the infection situation of wild boars.

Conclusion

When analyzed collectively, all the information generated from our study shows that wild boars in Vojvodina region are not a reservoir for CSFV and PRRSV infection and are endemically infected with PPV. The highest antibody prevalence was detected for PPV and confirms that this viral agent is widespread in hunted wild boars in six different districts. Our results show that PRRSV infection in wild boars in Vojvodina is more sporadic, and a low circulation rate of the virus among wild boars suggests no significant influence of PRRSV in this species.

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. Avoiding close contact between wild boars and domestic animals is of logical importance in disease control and eradication program. Further and more comprehensive research is needed including testing of wild boar samples from a few hunting seasons on antibody and virus presence to obtain more conclusive results on presence of viral infections in wild boars in Vojvodina.

Acknowledgment

This paper is a result of the research within the project TR 31084 “Wild animal health monitoring and introduction of new biotechnology procedures in detection of infectious and zoonotic agents – risk analysis for human health, domestic and wild animal health and for environmental contamination”, financed by the Ministry of Education, Science and Technological Development, Republic of Serbia.

References

1. Albina, E., Mesplede, A., Chenut, G., Le Potier, M.F., Bourbao, G., Le Gal, S., Leforban, Y. (2000): A serological survey on classical swine fever (CSF), Aujeszky's disease (AD) and porcine reproductive and respiratory syndrome (PRRS) virus infections in French wild boars from 1991 to 1998. *Vet Microbiol*, 77, 43-57.
2. Artois, M., Depner, K.R., Guberti, V., Hars, J., Rossi, S., Rutili, D. (2002): Classical swine fever (hog cholera) in wild boar in Europe. *Rev. Sci.tech.Off.Int.Epiz.*, 21, 2, 287-303.
3. Boadella, M., Ruiz-Fons, J.F., Vicente, J., Martin, J., Segales, J. and Gortazar, C. (2012): Seroprevalence Evolution of Selected Pathogens in Iberian Wild Boar. *Transboundary and Emerging Diseases*. 59, 395–404.
4. Frölich, K., Thiede, S., Kozikowski, T., and Jakov, W. (2002): A Review of Mutual Transmission of Important Infectious Diseases between Livestock and Wildlife in Europe. *Ann. N.Y. Acad. Sci.* 969, 4-13.
5. Grimoldi, F., Jauregui, L. H., Guida, N., Barboni de Stela, A. M., Moras, E. V. (1998): Serological prevalence of porcine parvovirus in Argentina. 15th IPVS Congress, Birmingham, Proceedings, 44.
6. Huysman, C. N., van Leengoed, L. A. M. G., de Jong, M. C. M., van Osta, A. L. M. (1992): Reproductive failure associated with porcine parvovirus in an enzootically infected pig herd. *Vet Record*, 131, 503-506.

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UDC: 639.111.1

7. Kaden, V., Kramer, M., Kern, B., Hlinak, A., Mewes, L., Hänel, A., Renner, C.H., Dedek, J., Bruer, W. (2006): Diagnostic procedures after completion of oral immunisation against classical swine fever in wild boar. *Rev. sci. tech. Off. int. Epiz.*, 25,3,989-997.
8. Le Potier, M. F., Mesplede, A. & Vannier, P. (2006) Classical swine fever and other pestiviruses. In *Diseases of swine*, eds Straw, B. E., Zimmerman, J. J., D'Allaire, S. & Taylor, D. J., 9th edn. Oxford, Blackwell Publishing, 309-322.
9. Lupulović, D., Milić, N., Petrović, T., Prodanov, J., Valčić, M., Lazić, S. (2007): Ispitivanje značaja vakcinacije protiv parvoviroze svinja kod perzistentno inficiranih krmača. *Veterinarski glasnik*, 61, 5/6, 163-171.
10. Meng, X. J., Lindsay, D. S., and Sriranganathan, N. (2009): Wild boars as sources for infectious diseases in livestock and humans. *Phil. Trans. R. Soc. B*, 364, 2697-2707.
11. Montagnaro, S., Sasso, S., De Martino, L., Longo, M., Iovane, V., Ghiurmino, G., Pisanelli, G., Nava, D., Baldi, L., and Pagnini, U. (2010): 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.
12. Prodanov, J., Došen, R., Pušić, I., Petrović, T., Orlić, D., Maljković, M., Lupulović, D. (2009): The control of classical swine fever virus presence in wild boars population. *Biotechnol Anim Husb* 25, 5-6, 879-885.
13. Prodanov-Radulović, J., Došen, R., Pušić, I., Orlić, D., Stojanov, I., Radulović, G., (2010): Verinozna pneumonija divljih svinja. *Arh.vet. med.*, 3, 2, 19-25.
14. Prodanov-Radulović, J., Došen, R., Pušić, I., Petrović, T., Stojanov, I. (2013): Health status control of wild boars in the hunting area of Vojvodina region. 10th International Symposium Modern Trends in Livestock Production, Belgrade, Proceedings, 1182-1188.
15. Roić, B., Čajavec J., Tončić, J., Madić, J., Lipej, Z., Jemeršić, L., Lojkić, M., Mihaljević, Ž., Čač, Ž., Šoštarić, B. (2005): Prevalence of Antibodies to Porcine Parvovirus in Wild Boars (*Sus scrofa*) in Croatia, *Journal of Wildlife Diseases*, 41,4, 796–799.
16. Roić, B., Jemersić, L., Terzić, S., Keros, T., Balatinec, J., Florijancic, T. (2012): 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.
17. Rossi, S., Fromont, E., Pontier, D., Crucièrè, C., Hars, J., Barrat, J., Pacholek, X., Artois, M. (2005): Incidence and persistence of classical swine fever in free-ranging wild-boar (*Sus scrofa*). *Epidemiol. Infect.*, 133, 559-568.
18. Ruiz-Fons, F., Vicente, J., Vidal, D., Hofle, U., Villanua, D., Gauss, C., Segales, J., Almeria, S., Montoro, V., Gortazar, C. (2006): Seroprevalence of six reproductive pathogens in European wild boar (*Sus scrofa*) from Spain: The effect on wild boar female reproductive performance. *Theriogenology*, 65, 731–743.
19. Ruiz-Fons, F., Segales, J. & Gortazar, C. (2008): A review of viral diseases of the European wild boar: effects of population dynamics and reservoirs role. *Vet. J.*, 176, 158–169.
20. Sedlak, K., Eva Bartova, and Jirina Machova: Antibodies to Selected Viral Disease Agents in Wild Boars from the Czech Republic *Journal of Wildlife Diseases*, 44(3), 2008, pp. 777–780
21. Sorensen, K. J., Madsen, P., Lei, J. C. (1988): Efficacy of an inactivated porcine parvovirus (PPV) vaccine under field conditions. *Acta vet. Scand.*, 29, 295-302.
22. Vengust, G., Grom, J., Bidovec, J. A., Kramer, M. (2006): Monitoring of Classical Swine Fever in Wild Boar (*Sus scrofa*) in Slovenia. *J. Vet. Med. B*, 53, 247–249.
23. Wu, N., Abril, C., Hinić, V., Brodard, I., Thür, B., Fattebert, J., Hüsey, D., Ryser-Degiorgis, M-P. (2011) Free ranging wild boar: a disease threat to domestic pigs in Switzerland? *Journal of Wildlife Diseases*, 47, 4, 868-879.

FINDINGS OF TICKS IN SOME SPECIES OF WILD CARNIVORES

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Summary: In the natural habitat of Vojvodina, there are different species of carnivores. The most common species inhabiting our hunting grounds include foxes (*Vulpes vulpes*) and jackal (*Canis aureus*). They are well adapted to living in diverse habitats and can have both useful and harmful influence on the nature. One of their negative impacts is reflected in the possibility to carry or transfer, via the vector, a range of contagious diseases, which can be dangerous for wild and domestic animals as well as for humans. Among the hematophagous parasites that endanger the population of wild animals, ticks play a particular role because of their impact on the health either directly by causing parasitic infection or as vectors of diverse infectious diseases. Monitoring of presence of these ectoparasites enables assessment of prevalence of ticks and collection of data on possible infectious diseases. In that respect, the objective of our study was collecting ticks in foxes and jackals with an aim of determining the hunting grounds that are inhabited by carries of these parasites and identifying tick species that are most prevalent in the investigated wildlife population. The ticks were collected from hunted animals that were submitted to the laboratory for examination. The examined population encompassed 23 hunted foxes and 20 jackals. The animals originated from two hunting grounds from Srem and one from Bačka. The presence of 4 species of ticks was confirmed: *Dermacentor marginatus*, *Haemaphysalis punctata*, *Ixodes ricinus* and *Rhipicephalus sanguineus*.

Keywords: foxes, jackal, ticks, health

Introduction

Natural and hunting grounds in the territory of Vojvodina (Srem and Fruska Gora) are inhabited by two most common types of carnivores belonging to the *Canidae* family - foxes (*Vulpes vulpes*) and golden jackal (*Canis aureus*) (Ristić, 2008). Foxes are widespread in Europe, Asia and North America. This animal inhabits wooded areas and feeds with different small rodents. Jackal is very close relative of dogs and inhabits the wooded and grassy landscapes (Ristić, 2008). Both animal species are present in the territory of Vojvodina, which is part of a specific lowland ecosystem. As carnivorous predators, their role is important in terms of control of the presence of small rodents, which causes damage to agricultural crops (mouse, rat, hamster). On the other hand, they can be fed with dead or hunted animals, and thus play a role in the "cleaning", i.e. removal of animal remaining from the nature. At the present time, because of the reduction of natural habitats (Bradley and Altizer, 2007), i.e. the disappearance of boundaries between the settlements and the nature, the animals are increasingly coming into direct contact with the man. Foxes and jackals, more than previously, can come to the municipal solid waste landfills or even to a place for disposal of garbage on the outskirts of settlements (villages and towns). This type of contact can favour the transfer of the diseases between different animal species such as foxes and jackals, as well as between domestic carnivorous animals. This may lead to the spread of infectious and parasitic diseases as well as to creation of the reservoirs of disease, which will continuously disseminate the infectious agents in the nature as well as among animal population in urban areas.

Parasitic diseases that can be transmitted from wild to domestic animals include tick-born ectoparasitoses (which may result in the presence of tick-transmitted diseases) that pose particular threat

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to both animals and humans. Ticks belong to the order Acarina suborder Metastigmata. Ticks are blood-sucking parasites inhabiting different ecological niches (Dantas-Torres and Otranto, 2013), which mainly depends of the host and its living environment.

Ticks are present in pastures and meadows as well as in forests or caves with appropriate microclimate conditions and suitable hosts (Dantas-Torres and Otranto, 2013). As compared to other groups of hematophagous arthropods, parasites that are distributed worldwide (Durden, 2006) endangering humans, pets and farm animals, ticks are vectors of a large number of animal and human pathogens such as *Borrelia burgdorferi*, a causative agent of Lyme disease (Pfaff et al. 2013), a wide range of Rickettsia species as well as *Anaplasma spp.* (Nieder et al.2013), *Ehrlichia spp.* (Paddock and Telford, 2011), *Babesia spp.* (Pavlović et al. 2003), as well as numerous viruses and bacteria.

So far, only limited research of the presence and prevalence of ticks in Vojvodina in wild carnivores has been conducted. For these reasons, the objective of our study was to collect the ticks from hunted foxes and jackals from certain regions of Vojvodina. The aim of the research was to determine the types of ticks that are present in this area, the relationship of the sexes within the investigated population and to establish potential differences between tick populations in the fauna of separated hunting grounds.

Material and Methods

In our study, capturing foxes and jackals in order to determine which parasitic fauna could be found on living animals was not possible. For this reasons, ticks were collected from hunted animals and subsequently identified. Potential disadvantage of this method of testing is reflected the fact that the number of ticks on hunted animal might have been depending on how long hunted animals have spent at the place of the shooting. Examination of hunted foxes and jackals on the presence of ticks was carried out throughout the period of the hunting season, i.e., from November to March.

Since high-quality samples from large number of hunting grounds could not be provided, analysis for the presence of ticks in both carnivore species was performed using the materials from three hunting areas, two in Srem (Ruma and Pećinci) and one in Titel. The study included 23 hunted foxes and 20 jackals. The animals were obtained from hunting grounds directly from the spot where it was collected. Hunted foxes and jackals were kept in the hunting grounds averagely three days (1-5 days) and then delivered to the laboratory. Collected ticks were kept alive or preserved in 96% ethanol until final identification. In the laboratory, ticks were classified by stage and sex and determined according to standard taxonomic keys by Pomerancev (1950), Kapustin (1955) and Kolonin (2009).

Results and discussion

The results of the testing for presence of ticks in samples obtained from hunted foxes and jackals are presented in Table 1. Each tested animal was carrying more than one different type of ticks. The table contains data on the presence (%) of certain species of ticks for each of three hunting areas from which the animals originated.

Table 1 Presence of ticks in hunted foxes and jackals.

	Tick species	Fox			Jackal		
		total	positive	(%)	total	positive	(%)
1	<i>Ixodes ricinus</i>	23	11	47.86	20	11	55.00
2	<i>Dermacentor marginatus</i>	23	10	43.47	20	9	45.00
3	<i>Rhipicephalus sanguineus</i>	23	2	8.69	20	1	0.50
4	<i>Haemaphysalis punctata</i>	23	1	4.34	20	-	-

Ticks identified in hunted foxes and jackals belong to the family of Ixodidae. This family includes 14 genera, among which the genera *Ixodes*, *Dermacentor*, *Rhipicephalus*, *Haemaphysalis* and *Hyalomma* are of importance for human and animal health (Milutinović et al.2012, Guglielmone et al., 2010, Estrada Pena and Jongejan 1999). Our study revealed the highest prevalence of *Ixodes ricinus* and *Dermacentor marginatus* in hunted foxes and jackals, which predominated over other tick species. During

examination, we found only adult ticks whereas ticks at larval stage were not observed. Our results showed that the occurrence of tick species found in foxes is similar with species that were found in wild *Canidae* in Central Europe - Germany, Italy, Austria and Hungary (Hinaidy, 1976, Schoffel et al. 1991, Sréter et al. 2005, Lorusso, 2011).

In the territory of Serbia, the studies of ticks in foxes have been made only sporadically. According to the findings of Pavlović et al. (2001), presence of *I. ricinus*, *R. sanguineus*, *R. bursa*, *H. punctata*, *H. inermis*, *D. marginatus* and *D. reticulatus* was established in foxes and badgers from the area of central Serbia. The studies on ticks fauna of red foxes including 17 animals from the east and south-west parts of Serbia performed by Tomanović et al. (2013) revealed presence of *I. ricinus* (62.86%), *I. canisuga* (14.28%), *I. hexagonus* (10%), *H. concinna* (7.14%) and *D. reticulatus* (5.71%). Our results are similar and confirm that certain types of ticks, primarily *I. ricinus*, are dominant in foxes.

Moreover, our findings confirmed the results on the prevalence of these two species reported by Milutinović et al. (1998), and Pavlović et al. (2003) who monitored the presence of ticks in various species of domestic and wild animals. *I. ricinus* is the most common tick species in both Serbia and Western Balkans. It was established in the researches that included analysis of the presence of ticks in cattle, pigs, sheep and goats in eastern, central and western Serbia (Milutinović et al. 1997, 1998) and Kosovo (Pavlović et al. 1995). Similar results were obtained in Macedonia (Pavlović et al. 2014) where *I. ricinus* was the dominant ectoparasite of cattle, sheep and dogs in the region of Kumanovo. Our findings demonstrated seasonal variations of the presence of *I. ricinus* over the years characterized by spring-summer and autumn peak values, which corresponds with the biology of this species. Otherwise, *I. ricinus* can parasitize in over 300 different vertebrate species and is one of the most common tick species in the world (Dumitrache et al. 2012, Nicholson et al. 2009).

D. marginatus usually infects sheep, cattle, deer, dogs, humans, rabbits and hedgehogs. Developmental forms of the parasite were found in small mammals and birds (Dumitrache et al. 2012). *R. sanguineus* is a tick that can be found in a wide variety of mammals but the dogs are the most common host (Dumitrache et al. 2012). *Haemaphysalis punctata* is a species of tick, which was found in some types of mammals as well in the reptiles in Serbia. (Pavlović and Milutinović 1999, Pavlović et al. 2013(a)).

Tick species, whose presence is confirmed in hunted foxes and jackals, have been identified as an important link in the transmission of infectious diseases such as Lyme boreliosis, tularaemia, tick-borne encephalitis, babesiosis, anaplasmosis and ehrlichiosis (Dimitrić, 1999, Goddard, 2003) as well as diseases caused by Rickettsia or other bacterial and viral disease.

The results on the presence of ticks in hunted foxes and jackals according to the hunting grounds and interrelationship of ticks by gender are presented in Table 2. Each animal was carrying a larger number of ticks. The data in the table are expressed as the numbers of found ticks.

Table 2. Contains a tick and a half in the shot game in the hunting

	Tick species found in animals	Ruma (No.)	Pećinci (No.)	Titel (No.)
1	<i>Ixodes ricinus</i>	10	20	23
2	<i>Dermacentor marginatus</i>	15	11	18
3	<i>Rhipicephalus sanguineus</i>	2	1	5
4	<i>Haemaphysalis punctata</i>	2	2	3

The presence of ticks and their distribution has been increasingly investigated from the aspect of climate changes that affects the environment as well as in view of the number of wild animals and their migration. In that respect, the biology of ticks is strongly dependent on their ability to attach to the host and transfer from one region to the other (Milutinović et al. 2012, Randolph, 1998). The effect of microclimate parameters such as temperature, wind, and humidity may contribute to an increase or decrease in the number of ticks (Brownstein et al. 2005).

In our study, the finding of ticks in hunted foxes and jackals demonstrated that areas that are not related to water surfaces (swamps, rivers and channels), e.g. the hunting ground of Ruma, is characterized by lower prevalence of ticks as compared with the hunting area that is in contact with the natural or artificial water surface. Some studies demonstrated the substantial importance of humidity for the survival and activity of ticks (Vial, 2009). Kahl and Knulla (1988) reported that some types of ticks, including

Ixodes and *Dermacentor* species, demand humidity of habitat min 80%. Decrease of humidity below 80% significantly reduces the possibility of tick's survival in the long run. Data on the intensity of the presence of different types of ticks and its relation with climatic conditions are presented in the articles of Milutinović et al. (1997, 2012). It is obvious that high humidity and large amounts of precipitation in the period May - June, led to a peak of tick populations that require high relative humidity (*Ixodes ricinus* and *Rhipicephalus* spp.).

With respect to sex ratio within individual species, our findings demonstrated that female ticks dominated in five species whereas in two species the males were dominant gender. Similar results were obtained by Milutinović et al. (1997, 1998) and Pavlović et al. (2013(b), 2014)

Conclusion

During the research period, , the presence of four different types of ticks (*Ixodes ricinus*, *Dermacentor marginatus*, *Rhipicephalus sanguineus*, and *Haemaphysalis punctata*) was confirmed in hunted foxes and jackals. The dominant species were *Ixodes ricinus* (just over 50%) and *Dermacentor marginatus* (44.15%) and all identified tick were females. The study showed that the number of the found ticks is related with the structure of the hunting area. The number of ticks was lower in animals originating from hunting areas that were not bordering waterways or water surfaces. These differences can be explained by specific features of the habitat (humidity) from which the animal originates, as well as by the fact that animals were not delivered for examination immediately (on the same day) after they had been hunted.

Acknowledgement:

This investigation was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Project No. TR 31084.

References

1. Bradley, C., Altizer, S.: Urbanization and the ecology of wildlife diseases. *Trends Ecol. Evol.* 22, 95–102., 2007.
2. Brownstein, J.S., Holford, T.R., Fish, D.: Effect of Lyme disease risk in North America. *EcoHealth* 2, 38–46., 2005.
3. Dantas-Torres F., Otranto D.: Species diversity and abundance of ticks in three habitats in southern Italy *Ticks and Tick-borne Diseases* 4, 251– 255, 2013
4. Dimitrić A. Fauna i ekologija krpelja (Acari:Ixodidae) kao prenosioca metazoonoza. MSc thesis, Faculty of Veterinary Medicine University in Belgrade. 1999.
5. Dumitrache o. M., C. M. Gherman, Vasile Cozma, V. Mircean, A. Györke, A. D. Sándor, A. D. Mihalca; Hard ticks (Ixodidae) in Romania: surveillance, host associations, and possible risks for tick-borne diseases, *Parasitol Res* 110:2067–2070, 2012.
6. Durden, L.A: Taxonomy, host associations, life cycles and vectorial importance of ticks parasitizing small mammals. In: Morand, S., Krasnov, B.R., Poulin, R. (Eds.), *Micromammals and Macroparasites. From Evolutionary Ecology to Management*. Springer Verlag, Tokyo, pp. 91–102. 2006
7. Estrada-Peña, A., Jongejan, F.: Ticks feeding on humans: a review of records on human-biting Ixodoidea with special reference to pathogen transmission. *Exp. Appl. Acarol.* 23, 685–715., 1999.
8. Goddard J: *Physician's guide to arthropods of medical importance*, 4th edn. CRC Press LLC, Florida, 2003.
9. Guglielmone, A.A., Robbins, R.G., Apanaskevich, D.A., Petney, T.N., Estrada- Peña, A., Horak, I.G., Shao, R.F., Barker, S.C.: The Argasidae, Ixodidae and Nuttalliellidae (Acari: Ixodida) of the world: a list of valid species names. *Zootaxa* 2528, 1–28, 2010.
10. Hinaidy, H.K.: Ein weiterer Beitrag zur Parasitenfauna des Rotfuchses *Vulpes vulpes* L. in Osterreich. *Zentralblatt für Veterinarmedizin Reihe B*, 23: 66–73., 1976.
11. Kahl, O., Knülle, W.: Wirttsuchaktivität der Schildzecke, *Ixodes ricinus* (Acari, Ixodidae) und ihre Durchseuchung mit Lyme-Spirochäten und dem Frühsommer-Meningoencephalitis (FSME)-Virus in Berlin (West). *Mitt. Dtsch. Ges. Allg. Angew. Entomol.* 6, 223–225., 1988.
12. Kolonin G.V.: Fauna of ixodid ticks of the world (Acari:Ixodidae), Moscow, p.3-141 <http://www.kolonin.org/3.html>, 2009.
13. Kapustin, F.U.: Atlas parazitov krovi životnih i klešćei iksodid, Ed. Gasudarstvenoe izdetejlstvo seljskohazajstvenoi literaturi, Moskva, 1955.
14. Milutinovic M., Z. Petrovic, B. Bobic, I. Pavlovic: Ecological notes on ticks (Acari: Ixodidae) collected in West Serbia, Yugoslavia, *Parasit. hung.*, 29-30: 67-74, 1997.
15. Milutinović, M., Aleksić-Bakrač, N., Pavlović, I.: Reserch of tick population (*Acari: Ixodidae*) in eastern part of Serbia. *Ars Vet.* 14 (2), p.227-234, 1998.

16. Milutinović M., Radulović Ž., Tomanović S., Petrović Z.: Krpelji (Acari: Ixodidae; Argasidae) Srbije. SANU, knjiga DCLXX, Beograd, 2012.
17. Nicholson LW, Sonenshine ED, Lane RS, Uilenberg G: Medical and veterinary entomology, 2nd edn. Academic, London, 2009.
18. Nieder M, Bojkovski J, Pavlović I, Savić B, Elezović M, Silaghi C.: Studies on the occurrence of granulocytic anaplasmosis in cattle and on biodiversity of vectors (ixodid ticks) in Serbia. 18. godišnjeg savetovanja doktora veterinarske medicine Republike Srpske sa međunarodnim učešćem, Teslić, Republika Srpska (BiH). Zbornik kratkih sadržaja 25, 2013.
19. Lorusso, V., Lia, R.P., Dantas-Torres, F., Mallia, E., Ravagnan, S., Capelli, G., Otranto, D.: Ixodid ticks of road-killed wildlife species in southern Italy: new tick-host associations and locality records. *Experimental and Applied Acarology*, 55: 293-300., 2011.
20. Paddock, C.D., Telford, S.R. III : Through a glass darkly: the global incidence of tick-borne disease. In: Committee on Lyme disease and other tick-borne diseases: The state of science; Institute of Medicine (Eds.), Critical needs and gaps in understanding prevention, amelioration and resolution of Lyme and other tick-borne diseases: the short-term and long-term outcomes: Workshop report. The National Academic Press, Washington, DC, pp. A2–A43., 2011.
21. Pavlović I., Kulišić Z., Nešić D., Romanić S.: Ectoparasites of sheep and goats in Prizren district. 3rd International Conference of Sheep and Goat Production, Ohrid, Macedonia, Proceed. p.101-105, 1995.
22. Pavlović I., Milutinović M.: Infestacija tigrastog pitona (*Python molurus*) i send boe (*Boa constrictor*) krpeljima *Haemaphysalis punctata* (Canestrini & Fanzago, 1877). Zbornik rezimea simpozijuma entomologa Srbije 99, Goč, 48, 1999.
23. Pavlović I., Milutinović M., Radulović Z.: Fauna artropoda ekto parazita lisica (*Vulpes vulpes* L.) u Srbiji, Zbornik rezimea skupa entomologa Srbije 2001. 26-29.7.2001., Goč, 45. 2001.
24. Pavlović I., Milutinović M., Radulović Ž., Petković D., Terzin V., Terzin D.: Epizootological research of canine babesiosis in the Belgrade district, *Lucrari Stiintifice* vol 46, pg 365-370, 2003.
25. Pavlović I., Šekler M., Vidanović D., Obradović S., Kurčubić V.: First occurrence of ticks *Haemaphysalis punctata* on the European green lizyrd. *Proceeding of International Conference on Diseases of Zoo and Wild Animals*, Vienna, Austria, 168-169, 2013(a).
26. Pavlović I., Ivanović S., Zujović M.: Tick fauna of goat and sheep in Belgrade area. *Scientific Works. Series C. Veterinary Medicine*. Vol. LIX (1) 51-53, 2013 (b).
27. Pavlović I., Sr. Jovčevski, St. Jovčevski, V. Kukovska A., Dimitrić: Tick Fauna Of Sheep And Cattle At Kumanovo Arae (Macedonia). *Lucrări Științifice Medicină Veterinară XLVII* (3), 88-95, 2014.
28. Pfäffle M., Nina L., Senta V., Muders, Trevor N. Petney: The ecology of tick-borne diseases, *International Journal for Parasitology* 43, 1059–1077, 2013.
29. Pomerancev, B.L.: Fauna SSSR. Paukobraznie. Iksodovie kleščei (*Ixodidae*). Ed. Akademem Nauk SSSR, Moskva-Leningrad, 1950.
30. Randolph, S.E.: Ticks are not insects: consequences of contrasting vector biology for transmission potential. *Parasitol. Today* 14, 186–192., 1998.
31. Ristić A. Z.: LOVSTVO, Aston Kragujevac, 2008
32. Schöffel, I., Schein, E., Wittstadt, U., Hentsche, J.: Zur Parasitenfauna des Rotfuchses in Berlin (West). *Berliner und Münchener tierärztliche Wochenschrift*, 104: 153–157., 1991.
33. Sréter T, Széll Z, Varga I.: Spatial distribution of *Dermacentor reticulatus* and *Ixodes ricinus* in Hungary: evidence for change? *Vet Parasitol* 128:347–351, 2005.
34. Tomanović S., Radulović Ž., Čakić S., Mihaljica D., Sukara R., Penezić A., Burazerović J., Čirović D.: Tick species (Acari: Ixodidae) of red foxes (*Vulpes vulpes*) in Serbia, Book of Abstracts 2nd International Symposium on Hunting, » Modern aspects of sustainable management of game populations« Novi Sad, Serbia, 17 – 20. October, 2013.
35. Vial, L.: Biological and ecological characteristics of soft ticks (Ixodida: Argasidae) and their impact for predicting tick and associated disease burden. *Parasite* 16, 191–202., 2009

RETROSPECTIVE STUDY ON THE CAUSE OF DISEASE IN WILD ANIMALS IN VOJVODINA FROM YEAR 2011 TO 2014

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Summary: The Autonomous Province Vojvodina, one of the largest and rare biodiversity areal, that encompasses 21506 km², is faced with endangering and distinction of alarming number of plant and animal species. The Scientific Veterinary Institute in Novi Sad has initially participated in a one year pilot project, financially supported by the Secretariat for Science and Technological Development of Vojvodina. Afterwards, the project activities have been prolonged until year 2014, and included monitoring and determination of the cause of disease in protected and strictly protected wild animals. In the study, the mortality matrix and the observed seasonal changes in the wild animal populations were summarized and presented. Total of 498 carcasses were submitted to the Institute, including 14 species of wild birds and 4 of mammals. Complete *post mortem* examinations and accordingly selected laboratory assays were conducted. The obtained results indicate that major factors that are responsible for the death and losses in wild animals include global climate changes, human factor and increase of road traffic density.

Key words: protected wild animals, cause of disease, Vojvodina Province

Introduction

The Autonomous Province of Vojvodina is rare biodiversity centre in the Europe and extends over large area of 21506 km². Unfortunately, it is faced with endangering and distinction of alarming number of plant and animal species. Due to major interventions in the environment, numerous forests, meadows and marshlands have been converted to arable fields or urban communities with increasing infrastructure network. Such changes have influenced the wild animal populations to reduce in number or even vanish, like in case of the Great Bustard *Otis tarda*.

With few exceptions, wild animals live far from humans and urban areas. Due to their natural lack of thrust in man and all unusual objects in the habitat, actions such as monitoring, diagnostics, prevention and treatment of the diseases require changes in standard procedures (Prašović et al., 2003). In general, the primary diagnostics is mostly based on pathomorphological findings. Two regulations have been recently adopted, namely The Law of Protection of nature (2009) and The Bylaw on the Declaration and protection of strictly protected wild plants, animals and fungi (2010). The veterinary practitioners are engaged in health protection of the wild species, particularly those comprised in the later regulation.

The Scientific Veterinary Institute in Novi Sad has participated in a one year pilot project, financially supported by the Secretariat for Science and Technological Development of Autonomous Province Vojvodina. Afterwards, the project activities have been prolonged until year 2014, and included monitoring and determination of diseases and cause of death in protected wild animals. In the paper, summarized results of the study were presented in order to perceive the mortality and its major causes in wild animals.

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Material and Methods

During the period from the year 2012 to May 2014, total of 498 carcasses were submitted to the Institute, including 14 species of wild birds and 4 of mammals.

Complete *postmortem* examinations were conducted (Prašović et al., 2003).

The laboratory assays that included bacteriological and serological examinations, parasite and virus detection and determination of pesticide and other toxic materials, were selected according to section findings. Additionally, presence of Avian Influenza virus, West Nile infection and Newcastle disease virus were done using PCR technique (*Polymerase Chain Reaction*).

Chemical investigations included detection of toxic trace elements using Inductively coupled plasma mass spectrometry (ICP/MS) and pesticide detection with gas mass chromatography.

Results

The *post mortem* examinations were done in total of 498 wild animals, mostly birds that were submitted for section. In Table 1 results on cause of death are presented determined by *post mortem* findings and subsequent laboratory investigations. Closer analysis of the results has pointed toward two major group of factors that have lead to letal outcome (Table 2).

Impact of global climate changes.

In winter 2012, snowfalls and extreme weather with very low temperatures have been recorded and consequently state of emergency has been declared. Birds were submitted to section, including egrets, swans and coots. Pathomorphological findings were poor and indicated starvation, empty intestines, some grass particles and stones in the stomach colored with bile. In one grey egret haemopericard was detected. Laboratory investigations revealed small number of saprophytic bacteria. It was presumed that so called „hungry mortality“ or cachexia gravis caused death of birds.

During summer months, cases of dead birds, ducks, egrets, gulls etc., were frequently seen. The carcasses were mostly found solitary in the mud nearby dried up ponds, bogs, canals and river beds. The birds died suddenly and were in good shape. Most common findings were haemorrhagic enteritis, liver congestion and inflated small intestine. Infection with *Clostridium perfringens* was determined by bacteriological investigation. The obtained results were similar to Alphons et al. (2010). Due to resistant spore formation, clostridiosis is considered persistent disease hard to eradicate (Orlić and Kapetanov, 2007).

The results indicate that global climate changes and frequent extreme weather become important detrimental factors to animal health (Kapetanov et al., 2011; Kapetanov et al., 2011a). Tilman et al. (2001) has stated that increase need for food and estimated human population growth of more than 50% in the next decade, lead to simplification and loss of ecosystems, and possible extermination of many species. Moreover, lower crop yields, erosion and decrease of arable fields may arise (Sokos et al., 2013).

Anthropological factors.

Sporadic or mass death of gulls, wild ducks, pheasants and migrating cranes occurred frequently in spring during corn planting. Vulture species, like white-tailed eagles, buzzards, grey crows, foxes and jackals were also found dead nearby. On section, large portion of corn seed was found in crop and gizzard, while in oral cavity and gizzard macerated meat particles. In gulls and ducks, hyperemic and dilated capillaries with extravasations were present on brain meninges, as well as lung congestion and blood in both atria. Intoxication with furadan pesticide was confirmed by chemical-toxicological investigations. Since white-tailed eagles and cranes are strictly protected species, mass outbreaks of furadan poisoning has provoked public debates in Serbia and bordering countries. During period January-March 2014, severe furadan poisoning of grey partridges and vulture birds was recorded and detail report is submitted for publishing (Kapetanov et al., 2014).

Table 1. The cause of death in wild birds and animals after section and laboratory examinations.

Species	Number of carcasses	Diagnosis
Jackal(<i>Canis aureus</i>)	6	furadan intoxication
Jackal(<i>Canis aureus</i>)	4	killed on road
Pheasant (<i>Phasianus colchicus</i>)	36	parasite infestation (<i>Syngamus tracheae</i>)
	29	killed in traffic
Grey Partridge (<i>Perixperdix</i>)	16	killed in traffic
European Badger (<i>Meles meles</i>)	5	killed in traffic
White-tailed Eagle (<i>Haliaeetus albicilla</i>)	17	furadan intoxication
	5	poisoning with lead and arsenic
Swan (<i>Cygnus olor</i>)	12	cachexia gravis
	18	clostridiosis
Gull (<i>Larus cachinnans</i>)	43	clostridiosis
	88	furadan intoxication
Mallard (<i>Anas platyrhynchos</i>)	46	furadan intoxication
	41	clostridiosis
Black-necked Grebe (<i>Podiceps nigricollis</i>)	5	fire arm
	3	clostridiosis
Otter (<i>Lutra lutra</i>)	3	fire arm
Eurasian Coot (<i>Fulica atra</i>)	4	cachexia gravis
	5	clostridiosis
White Egret (<i>Ardea alba</i>)	3	cachexia gravis
	4	clostridiosis
Grey Egret (<i>Ardea cinerea</i>)	5	cachexia gravis
	7	clostridiosis
Common buzzard (<i>Buteo buteo</i>)	6	poisoning with lead and arsenic
Long-ear Owl (<i>Asio otus</i>)	3	fire arm
White Stork (<i>Ciconia ciconia</i>)	1	killed in traffic
Goldfinch (<i>Carduelis carduelis</i>)	83	mechanical injury
Total: 17 species	498	-

In the study of Novotny et al. (2011), consumption of insects, carcasses or seed treated with carbamate and organochlorine insecticide and used as rodent baits was the most frequent mean of intoxication. Domestic and wild animals that incidently intake baits are collateral damage (Kapetanov et al., 2012; Mihaljev et al. 2012). Despite furadan use has been banned since year 2007, it is still occasionally used to protect seed from insects (Berny, 2007; Wang et al., 2007; Berny and Gaillet, 2008). However, ingestion of seeds treated with pesticides was related to increased mortality rate in the offspring, while in high concentrations lower egg weight and poor eggshell hardness were determined (Berny, 2007).

Killing grebes, otters, eagles and other animals that readily feed on lake fish, was registered in more than few cases particularly nearby commercial ponds. Mostly rifle with small caliber and „solitary hooks“ were used to repel predators, despite the regulations that clearly forbid such actions. In several cases, owls

were shot by small caliber rifle out of superstition. By education and introduction of new declarations, improvements were evident in some European countries, as shown by Hunting guide (EC, 2008) and Danish Action plan to reduce gun shots of game birds by fire arms (Hicklin and Barrow, 2004).

Table 2. Distribution of major contributing factors in mortality pattern.

Major contributing factor	Number of cases	Number of species	Most frequent diagnosis
Human	16	13	furadan intoxication road traffic accident poisoning with lead and arsenic
Climate changes	10	5	cachexia gravis clostridiosis
Other	1	1	syngamiasis

Illegal trade or „bird trafficking“ was recorded on few occasions. Birds, packed individually in cartoon boxes, were condemned on border points. Mass death occurred during rescue. Discrete skin injuries on head and multiple haematomas just above the brain were present. Injuries of head and soft tissues were related to bumps to cage construction and mechanical force during transportation. It is considered that good management of wild becomes impossible without human interventions.

Due to increase of road traffic and infrastructure network without providing protective fences, cases of death by overrun were recorded in owls, foxes and badgers. It is interesting to note that in winter birds of fam. *Phasianidae* and small vultures were overrun most frequently during foraging. In summer, owls, badgers and foxes suffered in search for food for their offspring, particularly during night hunting.

Serological monitoring to Avian influenza is conducted regularly in Vojvodina province (Orlić et al., 2004) and in this study all samples were negative by PCR. However, during the survey the West Nile virus was detected in four Mute swans and two White-tailed eagles (Petrović et al., 2013).

Conclusion

Retrospective study on mortality pattern and predominant causes revealed some disturbing conclusions. The number of wild animals, particularly of protected species, that suffered violently is increased. Human factor seems to be the leading contributing determinant in mortality pattern. Seasonal changes of mortality pattern is partially changing and tends to expand throughout the whole year. First cases of West Nile virus in wild animals in Serbia were recorded.

Acknowledgment

This paper is a result of the research within the project TR31084, financed by the Ministry of Science and Technological Development, Republic of Serbia.

References

1. Alphons, J.A., van Asten, M., Georgios, N.N., Gröne, A. (2010): The occurrence of cpb2-toxigenic *Clostridium perfringens* and the possible role of the b2-toxin in enteric disease of domestic animals, wild animals and humans. *The Veterinary Journal*, 183, 135–140.
2. Berny, P. (2007): Pesticides and the intoxication of wild animals. *J Vet Pharmacol Ther.*, 30, 93-100.
3. Berny, P., Gaillet, J.R. (2008): Acute poisoning of Red Kites (*Milvus milvus*) in France: Data from the SAGIR network. *J Wildl Dis.*, 44, 417-426.
4. EC (2008): Guide to sustainable hunting under the birds Directive 79/409/EEC on the conservation of wild birds. European Commission.
5. Hicklin P. W., Barrow W. R. (2004): The Incidence of Embedded Shot in Waterfowl in Atlantic Canada and Hudson Strait. *Waterbirds*, 27, 41-45.
6. Kapetanov, M., Stojanov, I., Živkov Baloš, M. (2011): Most frequent deviations from the principles of prevention against coccidiosis in poultry. 3rd International Congress New Perspectives and Challenges of Sustainable Livestock Production, Belgrade. Proceedings, 2, 741-750.

7. Kapetanov, M., Potkonjak, D., MilanovD., Stojanov, I., ŽivkovBaloš, M., Prunić, B. (2011a): Pun naziv rada. ZbornikMaticesrpskezaprirodnenuke, 120, 269-278.
8. Kapetanov, M., Stojanov, I., Mihaljev, Ž. (2012): Mortality structure of the protected and strictly protected wild animals from Vojvodina region during one - year period. International symposium on hunting "Modern aspects of sustainable management of game population". Proceedings, 102-106.
9. Kapetanov, M., Potkonjak, D., Ratajac, R., ŽivkovBaloš, M., Ljubojević, D. (2014): Relationship between the use of pesticides and survival of Grey Partridge in Vojvodina. (in preparation for publishing)
10. Mihaljev, Ž., Živkov-Baloš, M., Kapetanov, M., Jakšić, S. (2012): Content of microelements in wild birds in Vojvodina. International symposium on hunting "Modern aspects of sustainable management of game population". Proceedings, 134-136.
11. Novotny, L., Misik, J., Kozlova, A., Ondracek, P., Kuca, K., Vavra, O., Rachac, V.(2011): Incidental poisoning of animals by carbamates in the Czech Republic. JournalofApplied biomedicine, 9, 157-161.
12. Orlić, D., Velhner, M., Kapetanov, M., Potkonjak, D., Stojanović, D. (2004): Serological control of avian influenza in northern region of Serbia.Proceedings, 4th International Symposium on Biocides in Public Health and Environment. Proceedings, 193-194.
13. Orlić, D., Kapetanov, M. (2007): Zarazne bolesti živine, Naučni institut za veterinarstvo „Novi Sad“, Novi Sad.
14. Petrović, T., Blazquez, A., Lupulović, D., Lazić, G., Escibano-Romero, E., Fabijan, D., Kapetanov, M., Lazić, S.,Saiz, J. (2013): Monitoring West Nile virus (WNV)infection in wild birds in Serbia during 2012: first isolation and characterisation of WNV strains from Serbia.Eurosurveillance, 18, 44, 1-8.
15. Prašović, S., Beširović, H., Šartović, E (2003): Obdukciona tehnika i patomorfološka dijagnostika važnijih bolesti ptica.Univerzitetski udžbenik, Sarajevo.
16. Sokos,C.K., Mamolos,A.P., Kalburtji, K.L., Birtsas, P.K. (2013):Farming and wildlife in Mediterranean agroecosystems. Journal for Nature Conservation, 21, 81– 92.
17. Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R. (2001):Forecasting agriculturally driven global environmental change. Science, 292,281–284.
18. The Law of Protection of nature (2009). The Official Gazette 36/09, Article No. 93.
19. The Bylaw on Declaration and protection of strictly protected wild plants, animals and fungi (2010). The Official Gazette 5/2010.
20. Wang, Y., Kruzik, P., Helsberg, A., Helsberg, I., Rausch, W.D. (2007): Pesticide poisoning in domestic animals and livestock in Austria: a 6 years retrospective study. Forensic Sci Int., 169,157-160.

PERSPECTIVES OF HUNTING TOURISM IN THE CONCEPT OF INTEGRATED EXPANSION OF RURAL ECONOMY

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Summary: With 43% of population living in rural areas, which includes at about 80% of a territory, rural expansion is vital to entire economic development of the country. This area is for a number of decades under the influence of various problems which have led to delays in its development as well as the loss of human resources and poor management of a various natural and cultural facilities, which directly implicate its devastation. We should point out, that rural area of Serbia is a potential area of development i.e. its huge part is unexploited and besides the fact that it has the potential opportunities in terms of increasing many activities, especially non-agricultural. This also applies to development of tourism as an activity that can have a significant influence on economic, demographic, social and functional structure of the rural area. One of its potentially promising aspects is hunting tourism. Hunting tourism is a specific form of tourism that is developing due to the desire of hunters to hunt outside their hunting grounds, hunting units and even out of state, and they pay for it certain fees. It is characterized by exclusivity, it contributes to extension of the tourist season, it is implemented in rural area and it contributes to the growth of the total income of all participants in its implementation.

Key words: development, hunting tourism, rural economy, integrated

Introduction

Natural characteristics of Serbia offer significant potentials for successful development of rural economy. Increase in quality of life in rural areas as well as encouraging diversification of economic activities are important demands for adjustment of the rural economy to modern development trends in this field. Potential investments in rural areas should be related to expansion of rural economy through creating and improving infrastructure, renovation and development of villages as well as protection and preservation of rural tradition. At the same time, necessity of continuous training of the local personnel is very important, because people as an active factor of production can contribute to alter the conventional structures to sustainable structures and activities in these areas.

Development of different aspects of tourism has significant function in the economy of rural areas. One of potentially promising aspects of tourism is hunting tourism. However, regardless of the natural attraction of domestic rural area, hunting tourism is slowly evolving comparing to demand and supply in the neighboring countries (Hungary, Austria, Slovenia, and Italy).

Material and methods

The aim of this work is to understand the situation and development possibilities of hunting tourism in the rural areas of Serbia. The aim and the object of this research have influenced the choice, sources and the way of using indicators and literature, as well as application of certain methodology. In this paper we analyze the main resources for development of hunting tourism, explore its basic characteristics, point out the problems of its development and we give recommendations for the purpose of future development

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in the concept of integrated rural development. The methodology used in this research represents application of structural analysis and statistical and mathematical methods. We used theoretical approach based on domestic and foreign literature; we examined empirical data, and analyzed existing statistical and economic indicators and all necessary parameters on the capacity of hunting, incomes and rural economy development.

Results and discussion

Nowadays, the development of rural areas receives a special attention and most of the developed countries establish special models of policy relating to the needs of the village. For a long time, in all countries, the development and progress of society was not tied to the village and agriculture, but for the industry and advanced technology as the main characteristics of innovativeness. Therefore rural areas became more and more delayed from the concept of modernization and also become periphery of development, until the modern processes pointed out the problems of this approach and showed potentials for sustainable development which these areas have. In the current conditions, an integrated rural area development combines spatial, temporal and multi-sectoral dimension (Radovanovic, 2010). Considering that in the rural areas major changes take place on a daily basis, the development can only be achieved in a parallel accomplishment and modernization of this area with the new trends of progress.

Sustainable development of rural areas of Serbia basically depends of practical application of a combination of the concept of multifunctional agriculture and integrated approach to the entire improvement of living conditions as well as socio economic status of villages and rural communities through increased employment opportunities outside agriculture (increasing the diversity of economic activities), in accordance to the available resources. Current trends in implementation of rural policy are based on the following principles:

- * Multifunctionality of agriculture – altered position of agriculture in the modern economic conditions, resulted in necessity of developing services in villages;
- * Multi-sectoral and integrated approach to rural economy in the direction of activity diversification; creation of new sources of income and possibilities of employment
- * Flexibility of rural development sources- based on self-help and decentralization, coordination and partnership at local, regional and national levels.

Basically, the concept of multifunctionality promotes the need that the system of agriculture production, besides its basic function, also has a number of non-production contributions related to sustainable rural development as well as strong social demographic component.

Increasing in the competitiveness of the economy of these areas to a large extent should be based on the exploitation of the opportunities offered through diversification of economic activities, focusing on quality and extra value of the product, demands of the customers etc. Our country should invest in improvement of social and economic conditions in rural areas, especially in remote rural areas which are faced with intensive depopulation. Investment in the rural economy and rural communities are vitally important in improving the quality of life in rural areas, which is reflected in better access to basic services and infrastructure, revenue growth and total sustainability.

Rural non-agricultural activities largely participate in full-time employment in rural areas. These various activities, such as manufacturing and service activities play the key role in maintaining the rural population, in stimulation of agricultural growth, in supply of consumer goods and various services. In the areas where few quality agriculture lands are prevailing, rural non-agricultural activities are offering important economic alternatives for poverty reduction. Appliance of appropriate rural activities in rural areas include new employment of rural population, reducing the risk for the farms which deals only with agricultural production, farm income topping with new economic activities using rural comparative

advantages (resources, locations), and all that with only one goal: faster village development and improvement of living standards in these areas.

Characteristics of development of hunting tourism

Tourism is an activity which is nowadays considered to have an outstanding contribution to economic growth and development of the economy. Tourism through its basic economic functions : direct, indirect, inductive, multiplicative and export, affects almost all branches of the economy and that way it creates multipliers of GDP growth, affects the entire employment, investments and enables acceleration of local and regional development and encourages foreign exchange inflow and balance of payments of the country. In fact, tourism has significant, both, direct and indirect impact on macroeconomic characteristics of each country and at the same time it provides intensification of development and increase of employment in tourist attractive and undeveloped areas.

Republic of Serbia has got a great number of resources for tourism development. By including economic and non-economic activities which have an interest for the development of tourism, it should become one of the generators of the development and the growth of total economic activity. Tourism as an industry achieved a value of \$ 2,510 million or 5, 6% of total GDP in 2013. (RZS (Republic Institute for Statistics); WTTC). The entire contribution of GDP included three key components:

* \$ 836 million was generated from direct traveling and tourism, which made 1.9 % of the total GDP of the economy;

* \$ 1,224 million was generated from indirect traveling and tourism, which made 2.8 % of the total GDP of the economy; and

* \$ 450 million was generated through induced tourism revenues, which made 0.9 % of the total GDP of the economy.

Direct contribution of tourism to total GDP of the economy includes expenses per tourist which are directly paid to participants in the tourism industry. This includes expenses in hotels and other types of accommodations, food and drink, transportation and other activities related to tourism. As well, direct contribution of tourism can be seen in the supporting indirectly associated economy through the purchase of supplies and through induced consumption by people directly and indirectly employed in this industry.

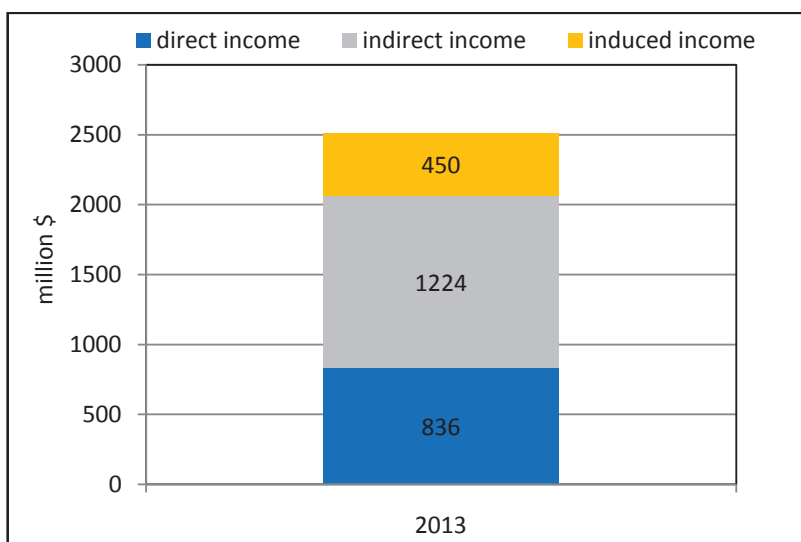


Chart 1. Structure of total tourism contribution to creation of GDP in Republic of Serbia in 2013.

As a contemporary basis of the rural economy and because of the decline in agricultural production, more and more people recommend rural tourism as an opportunity for the development of rural areas. Rural tourism is made of different forms of tourism outside the cities and mass tourism, required by attractions of rural areas, with various contents : tourism in family farms, hunting, fishing, sports-recreational , health, cultural, tourism of protected parts of the nature (national parks, nature parks) etc. This includes two groups of participants: tourists- multi-day visitors and excursionists- a day visitor.

On the tourist demand and according to the global trends, we can note down changes that speak of the increasing sophistication of demands and its requests in relation to the content, quality, price and other elements of specific destination. At the present time, the prevailing view is that the tourist demand is increasingly coming to the fore individualization of requirements with course on special interests, in which hunting also gets a special chance.

Hunting is an important socio-economic activity, especially in rural areas. The value of the hunting industry globally is constantly increasing, and it is, according to estimates, was in the EU at about 21.8 billion dollars in 2011. (FACE), and in the USA 34 billion dollars (U.S Fish &Wildlife Service) (Chart 2.).

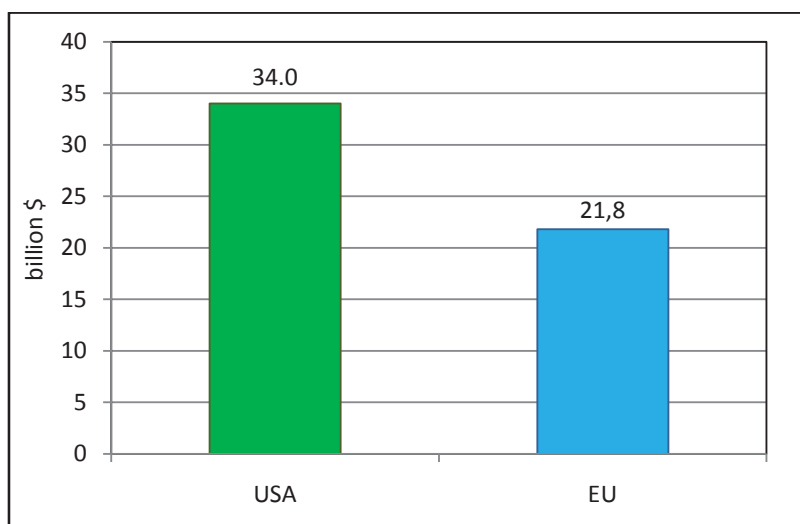


Chart 2. The value of the hunting industry in the USA and the EU in 2011.

Based on FACA (Federation of Association for Hunting and Conservation of the European Union) data, there were 7,353,071 hunters in Europe in 2010. Of this number, about ¼ occasionally travel abroad for hunting.

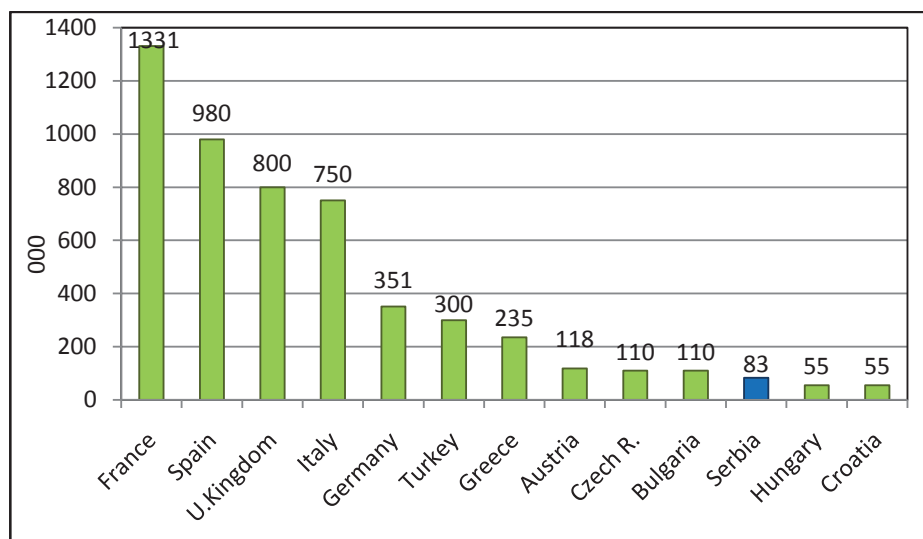


Chart 3. Number of hunters in certain countries of Europe in 2010

Hunting is a very popular activity and part of a tradition in Serbia. There were 388 hunting association registered in our country in 2011, including 85,140 members. The total hunting area was 6,844,393 hectares; of which the forest was 1,759,544 hectares. (Table 1.).

Table 1. Dynamic of changes in the number of hunting grounds and hunting areas in Republic of Serbia from 2001 to 2011.

Year	Number of hunting grounds	Index 2001=100	Hunting area in hectares				
			Hunting	Non-hunting	Total	Forested	Under forest (%)
2001.	418	100	5838878	873977	6712855	1434964	21.4
2003.	290	69	5909976	869194	6779171	1546845	22.8
2005.	381	91	6097214	928972	7026186	1726736	24.6
2007.	385	92	6142622	914058	7056680	1780997	25.2
2009.	388	93	6082702	954533	7037235	1723968	24.5
2011.	388	93	5830967	1013426	6844393	1759544	25.7
Average	375	-	5983726	925693	6909420	1662176	24.0

Source: Republic Institute for Statistics, Belgrade

Thanks to natural conditions, our country is rich in wildlife. Almost all European game species are present on its territory as constant or migratory game. It provides multiple benefits considering that it provides healthy products, achieves economic role and an important ecological function of biodiversity. Game is also important in the context of providing different recreational services, especially in present conditions of contemporary life (observing, taking photographs, shooting).

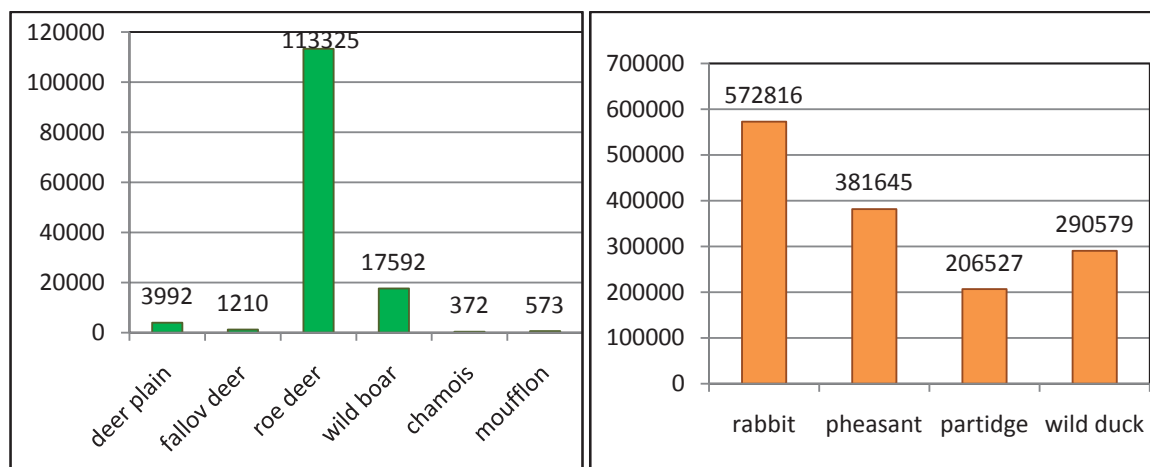


Chart 4. The number of population of large and small game in the area of Republic of Serbia, Ø 2009-2011.

Hunting represents significant and specific type of tourist arrangements. The specificity of this type of tourism is based on tourist traveling which is taken for implementation of the specific form of recreation such as hunting, shooting or observing wildlife in their natural habitat – hunting ground, where tourist- hunters are provided by different types of services such as accommodation, food, transport as well as other services in the segment of extra spending (Prentovic, 2006.). The participating hunter-tourists are generally very rich. This type of tourist movement is not characterized by mass but elitism, and it is an important factor of extending the tourist season for it lasts throughout the year and it is realized in rural areas. The main subjects in hunting tourism are hunters tourists (domestic and foreign), tourist agencies (organize, advertise and sell hunting travel arrangements), the organizers of hunting (hunting associations and other organizers of hunting), organizations for providing Services (transport, accommodation, food, equipment) and state institutions.

Hunting tourism has got a dual nature, as a specific segment of tourism and as a part of hunting, too. Interests of tourism and hunting industry in hunting tourism are realized, on one hand in the products of hunting (edible meat of wild animals, as culinary expensive and more luxurious materials for nutrition are highly demanded on the tourist market and hunting trophies) and on the other hand, interest of the tourists to participate in the hunting as a specific way of getting in touch with nature. This type of tourism is associated to a number of economic and non-economic activities, especially to forestry, agriculture, sports, education, science, culture and others.

Hunting tourism is an important element of continental tourism which encourages the development of an area inland and that way it extends the tourist season. The situation in Serbia is slowly improving in recent years, although it is not even close to the development of hunting tourism in the 80's; at the time that segment was in expansion and was attracting a significant number of strangers. Later, due to war, economic sanctions and expressed devastation of domestic economy, hunting tourism stopped developing and it had insignificant share in total tourist offer. In recent years there has been a trend of slight increase in visits of foreign hunters to domestic hunting grounds, as well as the income of their visit. Hunter-tourists mostly come from Austria, Italy, Germany, Greece, Spain, France and Hungary. Most large game hunters come from Germany and Austria, while small games mostly hunt Italians, Greeks and Spaniards.

The development of hunting and hunting tourism can be realized on productive basis considering whole system through the involvement of all interested participants. This type of tourism should be connected to development goals of rural economy that would enable the realization of income for local communities residing in rural areas and that would provide an opportunity for new workplaces.

Services related to hunting can have an important role in the development of tourism, because in this way they can be connected to rural areas and enable its prosperity. Investments in hunting tourism can be profitable since it is a relatively small investment as there are resources (game, hunting grounds), and significant financial effects can be achieved. Generally speaking, the development of hunting tourism perspective is from a standpoint of a time long-termed, but from the standpoint of entire gains it is very profitable. For example, hunting is an export oriented activity in Hungary, where about 25,000 to 30,000 foreign hunters come every year, of which 80% come from the EU, and where sales of meat are 20-22% of the total revenues in this sector. (Ristic et al.; 2013.).

Bearing in mind characteristics and current trends of hunting tourism in Europe and surrounding countries, we can conclude that the hunting tourism in Serbia is not explored enough, encouraged and adjusted to needs of modern tourist hunters. The current offer of hunting tourism in Serbia is underdeveloped and unstructured because existing tourist products are not developed enough, competitive and consistent, and their key players are not organized and synchronized in both private and public sector (hunting associations, tourist organizations, local governments and others). Due to these reasons listed above and the lack of a clear marketing strategy, this aspect of tourism still doesn't have recognizable market position and that generally results in low level of demand. Current problems of hunting tourism are related to disordered statistical sources, lack of promotion and marginalization of the role of hunting tourism in development concepts. It should be emphasized that creation of attractive hunting-tourist product is a long-term and expensive process which is payable only if it is valorized through multiple tangible and intangible benefits.

To attract more tourist-hunters, especially foreign ones, besides the things listed above and the things we have done so far, it is necessary to train stuff in this area and to improve and make a joint bid of hunting tourism with other aspects of tourism, in particular rural tourism, to consolidate the promotion of tourism by printing catalogues, making price list services and other publications about possibilities and offers in hunting tourism, supporting facilities etc.

In order to provide the sustainable hunting development in general and hunting tourism as its developing segment, it is necessary to control the total number of the game, in accordance with the capacity of natural habitat so as to avoid negative consequences in terms of endangering particularity of ecosystem. In this regard, it is essential to achieve compromise between commercial interests and environmental protection, so that hunting can become a recognizable "brand" and sustainable resource for tourism development.

Conclusion

Rural areas have strategic importance in our country because a large number of population live there and it includes a dominant part of the territory. Therefore, rural development is essential for the total economic development of the country, considering that the rural area represents an area of possible development and it has potentials for spreading many of these activities. In the structure of economic activities there are a large number of those which can be activated in the function of more intensive rural development. Essentially, successful development of rural economy should be based on diversification of agricultural and non-agricultural activities. As a modern basis of rural economy, because of the decline of agricultural production, tourism, as a new possibility for development of rural areas, is highly recommended. One of the activities linked to services development in rural areas is also hunting tourism. Our country has got good potentials for development of this form of tourism, but apart from that, satisfactory results are not achieved. The long tradition of hunting, relatively preserved hunting ground and above all valuable game resources, represents solid basis for the optimism concerning future development of hunting tourism in this area. For this type of tourism to be more dynamically developed in the future it is necessary to create a quality offer along with other types of tourism, especially rural, as well as to improve the promotion of the offers in hunting tourism and to achieve better coordination of all participants in the entire system of values.

References

1. Arsenov S. (2000). Agricultural policy, the development of tourism and catering in rural areas- a chance to increase employment, Rural and agribusiness development, The Institute of Agricultural Economics, Belgrade-Kopaonik, pp. 196-200
2. Đekić S. (2000). The importance of complementary development of agriculture and rural tourism, The first forum for rural tourism and sustainable development of the Balkans , AEERT, The Faculty of Science/ The Faculty of Economy, Kragujevac, pp.55-60
3. DGARI 2010, Rural development in the European Union, Statistical and economic information, report 2010.
4. Janković S. Čolić S. Rahović D. Tolimir N. (2009) Assessing the needs of producers in rural areas, Agricultural News 1-2, Belgrade, pp. 25-35
5. Marić R. (2001), Tourist activity- an important factor for prosperous development of rural areas, The first forum for rural tourism and sustainable development of the Balkans , AEERT, The Faculty of Science/The Faculty of Economy, Kragujevac, pp. 27-32.
6. Ministry of Agriculture, Forestry and Water Management of Republic of Serbia, Department of Forestry, 2011, Hunting development strategy for Republic of Serbia (professional basis for development), Belgrade.
7. Ministry of Agriculture, Forestry and Water Management of Republic of Serbia, (2009), Plan for strategic rural development 2009-2013.
8. Ministry of Agriculture, Forestry and Water Management of Republic of Serbia, (2011), The national program of rural development in Republic of Serbia 2011-2013.
9. Prentović R. (2006), Hunting ground – a special tourist destination, Tourism no 10, Modern trends in tourism, hospitality and gastronomy, Faculty of Science, Novi Sad, pp. 203-205
10. Radovanović V. (2010)., Integrated rural development- towards harmonious regional development, Proceedings of Matica Srpska for Social Sciences, no. 132, Novi Sad, pp. 41-51.
11. Republic Institute for Statistics, Database.
12. World Travel & Tourism Council, Database.
13. Ristić Z., (2008), Hunting and tourist valorization of turtle doves and quails in Vojvodina, Proceedings of the Department of Geography, Tourism and Hotel Management 37, Novi Sad, pp. 122-135
14. Ristić Z., Sajko Gabrijele, Simat Karolina, Matejević Milosava, (2013). Comparative review of hunting tourism in the Czech Republic and Hungary, Researches Review of the Department of Geography, Tourism and Hotel Management 42, Novi Sad, pp. 205-220
15. Šelmić V., Gačić D., Čeranić A., (2000). Hunt and hunting economy, Yugoslav Review 3, SJU RTJ , Belgrade, pp. 97-124.
16. Radović G., Pejanović R., Njegovan Z., (2012). The importance and the role of integrated rural tourist product in Republic of Serbia, Economic Views, vol. 17, no. 4, Belgrade, pp. 577-591
17. Stevanović Đ., (2000). Rural development, Economic policy, NIP Economic Policy, Belgrade
18. Law on Wildlife and Hunting (Official Gazette of Republic of Serbia no. 18/10)

MORPHOMETRIC CHARACTERIZATION OF BULGARIAN BARAK

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Summary: The Bulgarian barak is unstandardized and internationally unrecognized autochthonous breed of scent hounds. Austrian researcher Franz B. Laszka conducted first zootechnical research on scent hounds originating from the Balkans and divided these hounds into three groups based on hair type: short-haired, long-haired and wire-haired. The Bulgarian barak is the only long-haired scent hound breed known on the Balkans at this time.

The goal of our research was morphometric characterization, assessment and analysis of twelve exterior parameters in dogs of this breed found in the areas of Sofia, Železnica, Haskovo, Pazarčik and Kirgal.. Measurements were taken with Lyditi measuring stick, zootechnics measuring tape and slide ruler with nonius. A total of 64 dogs were measured, of which there were 36 males and 28 bitches. Statistical significance of difference between observed parameters in males and bitches was calculated using the T-test.

It was determined that the mean height at withers of males was 55.33 cm, and in bitches 51.28. Mean body length of males was 63.74 cm, and in bitches 63.09 cm. No statistical difference between sexes was found for this trait ($p > 0.05$). Mean head length of males was 24.55 cm, with range from 22.00 to 27.00 cm. Mean head length in bitches was 22.75 cm with range from 19.00 to 25.00 cm.

These results show that there are distinct differences between the Bulgarian barak and other, already studied, scent hound breeds from the Balkan peninsula. According to the exterior characteristics the Bulgarian barak is most similar to Bulgarian scent hound.

Key words: barak, morphometrics, scent hound, long-haired

Introduction

The Bulgarian barak is unstandardized and internationally unrecognized autochthonous breed of scent hounds. The term „scent hound“ refers to hunting dogs that hunt audibly. Such dogs respond vocally upon stumbling on the trail of the game, wherein they need not see the game itself, unlike sight hounds, who also pursue game, but must see it beforehand. Although there were many attempts, it has still not been established when this group of dogs inhabited the Balkan peninsula. According to one of the theories, scent hounds on the Balkans emerged from mixing of scent hounds from the region of Greece and scent hounds that came to Anatolia from India and came to the Balkans with the Turks. Other sources claim that scent hounds from the Balkans came to the region together with the migrating Celts and remained even when the Celts disappeared. (Stuhly, 1980).

Austrian scientist Franz B. Laszka carried out first zootechnical studies on scent hounds from the Balkans, primarily scent hounds from Serbia and Bosnia-Herzegovina. Research encompassed 1036 scent hounds and the results were published in the book on hunting in Bosnia-Herzegovina (Weidwerk in Bosnien und der Hercegovina, Klagenfurt, 1905). According to this author, the Balkan peninsula was the „hub“ for scent hounds, and scent hounds from the Balkans were used as founding material for numerous scent hound breeds from the West. Laszka differentiated scent hounds according to hair type and

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determined that there are three groups: short-haired, long-haired and wire-haired. The Bulgarian barak is the only long-haired scent hound breed known on the Balkans.

Standardized and recognized Balkan hound breeds, at present, are: Serbian hound (FCI standard 150), Serbian tricolour hound (FCI standard 229), Bosnian broken-haired hound called Barak (FCI standard 155), Hellenic hound (FCI standard 214), Scent hound from the Sava valley (FCI standard 154), Istrian short-haired scent hound (FCI standard 151), Istrian wire-haired scent hound (FCI standard 152), and Montenegrin mountain hound (FCI standard 279). Official FCI nomenclature assigns these dogs to group VI, Section 1 (scenthounds), subsection 1.2 (medium sized hounds) (FCI systematics, 2014.)

Beside these, standardized and officially recognized breeds, there are populations of dogs that have still not been through the standardization process. One of these breeds is the Bulgarian barak, origins from Bulgaria, and efforts are currently undertaken in order to standardize it.

Available literature contains no data on exterior characteristics for this breed. However, morphometric traits of other scent hound breeds from the Balkans were studied and the results were published. The first book on the Serbian hound (then called Balkans hound) was published on grounds of the research by S. Pavlović and S. Antić (1954). Mean height at the withers in bitches was 47.29 cm. Mean body length was 52.72 cm. Mean head length in bitches was 19.72 cm. Mean height at withers in males was 50.16 cm, mean body length was 56.18 cm, and mean head length was 20.98 cm. Work of these authors served as basis for the change of this breed's standard.

Exterior of Serbian scent hound was studied by Urošević et al. (1988). That research determined that the mean height at withers of Serbian (then Balkans) scent hound was 50.70 cm, mean body length was 56.20 cm, and mean head length was 22.90 cm. Mean height at withers in bitches was 47.90 cm, and mean body length was 52.80 cm, and mean head length was 21.60 cm. In Serbian (then Yugoslavian) tricolor hound, mean height at withers was 51.10 cm, mean body length was 56.20 cm, and mean head length was 22.50 cm. Mean height at withers in bitches of this breed was 48.60 cm, mean body length was 53.70 cm and mean head length was 21.50 cm.

Some data on exterior traits of Yellow Serbian hound populations is also available. In western Serbia, mean head length of males is 23.19 cm, and in bitches 21.8 cm, mean height at withers in males is 47.12 cm, in bitches 45.45 cm. (Drobnjak D. et al., 2009., 2010.) In southern Serbia mean height at withers in males is 54.98 cm, and in females 49.38 cm. Body format index in males is 115 and 117 in bitches. Mean head length in males is 24.17 cm, and in bitches 22.76 cm. Massiveness index is 120 in males and 124 in bitches. (Drobnjak et al., 2012.)

The only breed of hounds that has been described in Bulgaria thus far is the Bulgarian hound. According to available data, mean height at withers in males of this breed is 54.60 cm, and in females 51.73 cm. Mean crupper height is 53.12 cm in males and 50.93 cm in bitches. Both body format and massiveness index in males is 116 Body format index in bitches is 121, and massiveness index is 119. (Urošević et al., 2014.) Mean head length in males is 23.95 cm, mean skull length is 14.07 cm, and mean muzzle length is 9.69 cm. Mean head length in bitches is 23.53 cm, mean skull length is 13.83 cm, and mean muzzle length is 9.36 cm (Drobnjak et al., 2013.).

Material and Methods

Morphometrics, were studied, which included observation of 12 exterior parameters in 64 dogs. The observed population consisted of 36 males and 28 bitches that belong to the breed known as Bulgarian hound. Age of dogs in the observed population ranged from 1 to 8 years. All dogs were bred in the regions of Sophia, Železnica, Haskovo, Pazarčiko and Kirgali, and all had pedigrees issued by Kennel Club of Bulgaria. Measurement of the following exterior parameters were taken: height at withers, back height, crupper height, body length, head and skull length, muzzle length, width and depth, skull length, chest circumference and pastern circumference. Height was measured with Lyditi stick, while circumference was measured with zootechnics tape measure. Head length was measured with a ruler which incorporates Vernier's scale. (Atasoy et al., 2005; Drobnjak et al., 2010). Data was statistically processed in GraphPad Prism 5 software. Mean values of observed parameters, indexes, minimum and maximum values and descriptive statistics parameters (coefficient of variation, mean error and standard deviation) are presented. Significance in difference of observed parameters found in males and bitches was calculated using the t-test. Mean values of body development indexes were also analyzed: format

index, crupper high index, massiveness index, body compactness index, boniness index, head index, skull index and muzzle index.

Results

Mean height at withers in males was 55.33 cm, with range from 50.00 cm to 61.00 cm with CV of 5.22. Mean height at withers in bitches was 51.28 cm with SD 2.89. A significant statistical difference ($p < 0.001$) between sexes was determined for this parameter.

Mean back height in males was 52.58 cm, and in bitches 48.60 cm. A significant statistical difference ($p < 0.001$) between sexes was determined for this parameter. Crupper height range in males was 49.00 cm to 61.00 cm, and mean value was 52.93 cm., with CV 8.27. Mean crupper height in bitches was 51.81 cm. Range of this parameter, both in males and bitches, was quite large.

The obtained results are rather similar to those obtained from studies of exterior parameters of Bulgarian hound and Serbian yellow hound. If these values are compared to those found in Bulgarian hound, it becomes obvious that there are no significant differences in exterior parameters of these two breeds. The same conclusion follows if Bulgarian barak is compared to Serbian yellow hound population from southern Serbia. However, the Barak is taller than previously described hound breeds from the Balkan peninsula.

Mean body length in males was 63.74 cm, and in bitches 63.09 cm. There was no statistical difference between sexes for this parameter ($p > 0.05$). Chest circumference range was wide in both males and bitches. In males, it was from 60.00 cm to 79.00 cm, with CV 6.78, and in bitches range was from 59.00 to 70.00 cm, with CV 5.39. Mean pastern circumference in males was 11.38 cm with SD 0.95, while mean pastern circumference in bitches was 11.00 cm. Difference in this parameter between sexes had no significance ($p > 0.05$).

Mean head length in males was 24.55 cm, with range from 22.00 cm to 27.00 cm with CV 6.47 and SD 1.58. Mean head length in bitches was 22.75 cm with range from 19.00 cm to 25.00 cm, and CV 8.05. Mean skull length in males was 14.61 cm, and mean muzzle length was 9.72 cm. Mean skull length in bitches was 13.67 cm, and mean muzzle length was 9.55 cm. There is a statistically significant difference in skull length between sexes ($p < 0.05$). Range of skull width in males was from 14.00 cm to 16.00 cm, and in bitches from 12.00 cm to 15.00 cm. CV for this parameter was 4.75 in males, and 7.00 in bitches. There is a statistically significant difference in this parameter between sexes ($p < 0.05$). Mean muzzle width in bitches was 7.25 cm with SD 0.92, while mean muzzle depth was 8.27 cm with SEM 0.37. Mean muzzle width in males was 7.20 cm, and mean muzzle depth was 9.33 cm with SD 1.09. Differences in muzzle width between sexes were also statistically significant ($p < 0.05$). Values of parameters related to the skull were then compared to those values in other related breeds. There were obvious differences in head length between the Barak and Serbian hound, Serbian tricolour hound and Yellow hound, while the head of Bulgarian hound is almost identical in length.

In the following table are given statistical values for the observed traits, for both sexes together and separately for males and bitches. Statistical differences between sexes are also presented.

Body format index in males was 115.20, and in bitches 123.00. It's noticeable that bitches have a longer body than males, being 23% longer than their height at withers. Such proportions, in hounds, are not to be regarded as desirable. In comparison to other breeds, the Barak has the greatest body format. High croup index in males was 95.62, and in bitches 101.00, meaning that males do not have high croup, and bitches only slightly so. Massiveness index values in males was 119.66, and in bitches 125.00. This index is greater in bitches than in males, which is undesirable. Also, this value is comparable to values found in other hound breeds from the Balkans. Boniness index in males was 20.56. Body compactness index in males was 103.87, and in bitches 101.55. Head index in males was 44.37, and in bitches 44.36. Muzzle was shorter than the skull and these two indexes in males are in 40.50 : 59.50 ratio, while in bitches this ratio stands in 40 : 60 proportion. Skull width index was 60.30 in males and 59.91 in bitches. This indicates that the Barak belongs to the group of mesaticephalic dogs and that the skull width is greater than skull length.

Table 1. Statistical values of the observed parameters and statistical significance of intersexual difference in these parameters.

Parameter	Gender	N	Min	Max	CV	SEM	$\bar{x} \pm SD$	t
Height at withers	M	36	50.00	61.00	5.22	0.64	55.33±2.89	6.78 ^{***}
	F	28	47.00	57.00	6.03	0.72	51.28±3.09	
	Total	64	47.00	61.00	6.72	0.58	53.41±3.58	
Back height	M	36	48.00	60.50	6.29	0.75	52.58±3.30	4.49 ^{***}
	F	28	45.00	57.00	6.80	0.85	48.60±3.30	
	Total	64	45.00	60.50	7.53	0.65	50.82±3.82	
Crupper height	M	36	49.00	61.00	8.27	0.93	52.93±4.37	1.04 ^{ns}
	F	28	48.00	59.00	5.86	0.75	51.81±3.03	
	Total	64	48.00	61.00	7.36	0.62	52.46±3.86	
Body length	M	36	56.00	71.00	6.28	0.97	63.74±4.00	0.13 ^{ns}
	F	28	56.00	72.00	9.00	1.42	63.09±5.68	
	Total	64	56.00	72.00	7.60	0.83	63.42±4.82	
Chest circumference	M	36	60.00	79.00	6.78	1.08	66.21±4.49	1.31 ^{ns}
	F	28	59.00	70.00	5.39	0.89	64.07±3.45	
	Total	64	59.00	79.00	6.32	0.72	65.20±4.11	
Pastern circumference	M	36	10.00	13.00	8.39	0.33	11.38±0.95	0.00 ^{ns}
	F	28	10.00	12.00	8.13	0.36	11.00±0.89	
	Total	64	10.00	13.00	8.15	0.24	11.21±0.91	
Head length	M	36	22.00	27.00	6.47	0.47	24.55±1.58	1.38 ^{ns}
	F	28	19.00	25.00	8.05	0.64	22.75±1.83	
	Total	64	19.00	27.00	7.91	0.43	23.79±1.88	
Skull length	M	36	13.00	16.00	7.98	0.38	14.61±1.16	2.98 [*]
	F	28	11.00	16.00	11.57	0.52	13.67±1.58	
	Total	64	11.00	16.00	10.13	0.33	14.14±1.43	
Muzzle length	M	36	8.00	11.00	10.94	0.35	9.72±1.06	2.00 ^{ns}
	F	28	8.00	11.00	10.93	0.34	9.55±1.04	
	Total	64	8.00	11.00	10.65	0.24	9.63±1.02	
Skull width	M	36	14.00	16.00	4.75	0.24	14.81±0.70	2.81 [*]
	F	28	12.00	15.00	7.00	0.33	13.63±0.95	
	Total	64	12.00	16.00	7.15	0.25	14.22±1.01	
Muzzle width	M	36	5.00	9.00	17.38	0.39	7.20±1.25	2.96 [*]
	F	28	6.00	8.50	12.77	0.32	7.25±0.92	
	Total	64	5.00	9.00	15.06	0.25	7.22±1.08	
Muzzle depth	M	36	8.00	11.00	11.68	0.36	9.33±1.09	2.12 ^{ns}
	F	28	7.00	10.50	13.54	0.37	8.27±1.12	
	Total	64	7.00	11.00	13.65	0.28	8.80±1.20	

ns – not significant ($p > 0.05$); * - statistically significant ($p < 0.05$); *** - highly statistically significant ($p < 0.001$)

Table 2. Mean values of indexes for the observed traits in Bulgarian barak

Parameter	Gender	N	\bar{x} value (%)
Body format index	M	36	115.20
	F	28	123.00
	Total	64	118.74
High croup index	M	36	95.62
	F	28	101.00
	Total	64	98.22
Massiveness index	M	36	119.66
	F	28	125.00
	Total	64	122.07
Boniness index	M	36	20.56
	F	28	21.45
	Total	64	20.98
Body compactness index	M	36	103.87
	F	28	101.55
	Total	64	102.80
Head index	M	36	44.37
	F	28	44.36
	Total	64	44.54
Skull index	M	36	59.50
	F	28	60.00
	Total	64	59.43
Muzzle index	M	36	40.50
	F	28	40.00
	Total	64	40.57
Skull width index	M	36	60.30
	F	28	59.91
	Total	64	59.77

Conclusion

The obtained results indicate that there are significant differences between the Bulgarian barak and other described hound breeds that inhabit the Balkans. By exterior characteristics, Bulgarian barak is most similar to Bulgarian hound. The Barak belongs to the race of long-haired hounds first described by F. Laszka in 1905. And is, up to now, the only known long-haired hound breed in this region.

It was observed that massiveness index of these dogs is high, and that future breeding and selection must pay close attention to this trait, as it should on body format, in particular in bitches.

Results of this research are a stimulus for further analysis of this breed, monitoring of breeding and future selection, as well as a significant addition to efforts leaning towards the standardization of this the Bulgarian barak..

Acknowledgment

This paper is a part of the project “Making of a zootechnical study of the Bulgarian barak” undertaken by Center for preservation of indigenous breeds, Belgrade.

References

1. Anonym, (2012). Archive of Kennel Association of Serbia, Belgrade.
2. Atasoy, F., N. Ünal, O. Kanlı and A. Yakan, 2005. Damızlık Kangal köpeklerinde canlı ağırlık ve bazı vücut ölçüleri. *Lalahan Hay. Arşt. Enst. Derg.*, 45(1): 33–39.
3. Drobnjak, D. and M. Urošević, 2009. Origin and exterior characteristics of the Serbian yellow hound from the area of western Serbia; *Almanac of the 8th Congress of serbian veterinaries with international participation*, Belgrade, pages 534-541
4. Drobnjak, D. and M. Urošević, (2010): Head exterior parameters of Serbian yellow hound; *Almanac of the 21st Symposium of serbian veterinaries with international participation*, Zlatibor, pages 380-385
5. Drobnjak, D., M. Urošević, Y.Z. Oğrak and D. Matarugić, (2012): Basic exterior characteristics of Serbian Yellow Hound in Southern Serbia. *Eurasian J. Vet. Sci.*, 28 (2): 111- 115.
6. Drobnjak, D., V. Matić and D. Miliyević, (2010). Eksterijer pasa osnove procene, Tipo Štampa, Beograd, Serbia.
7. D.Drobnjak, M.M.Urošević, D.Končakov, M.B.Urošević ,(2013). : Basic head exterior characteristics of Bulgarian scent Hound - 5 International scientific – practical conference Conversation of animal diversity and wildlife management of Russia, Moskva. *Almanac of pepers*, pg. 145-148
8. Laska, R., (1905). *Das Weidwerk in Bosnien un der Hercegovina*, Klagenfurt.
9. Pavlović, S. and S. Antić, (1954). *Balkanski gonič*, Veterinary archives, Zagreb, book XXIV/1954, volume 1-2: 29-37.
10. Urošević, M., (2006). *Srpski i slični goniči*, Kennel club of Serbia and Montenegro, Belgrade.
11. Urošević, M., D. Drobnjak and B. Živković, (2009). Yellow Serbian Hound; *International conferece on hunting*, Žagubica.
12. Urošević, M., D. Drobnak, B. Živković and D. Matarugić, (2009b). The basic exterior parameters of Yellow Serbian Hound; *Agro – knowledge Journal*, 10 (2): 127-130.
13. Urošević, M., D. Latinović and B. Špoljarić, (1988). Comparative Study of the basic characteristics of body development in the Balkan, Yugoslavian tricolor and Yugoslavian mountain hound; *The First Yugoslav Conference on the domestic breeds of hound*, Valjevo.
14. Urošević M., Drobnjak D., Koncankov D., Ograk Y., Fury M., Matarugić D., (2014). Basic Exterior Characteristics of Bulgarian Scent Hound - *JAFAG* (2014) 31 (1), pg. 27-31

CIP - Каталогизација у публикацији
Библиотека Матице српске, Нови Сад

639.1(082)

**INTERNATIONAL Symposium on Hunting "Modern Aspects of
Sustainable Management of Game Population" (3 ; 2014 ;
Zemun)**

Proceedings of 3rd International Symposium on Hunting
with Abstract book [Elektronski izvor] / 3rd International
Symposium on Hunting "Modern aspects of sustainable
management of game population", 26-28. 9. 2014., Zemun,
Serbia ; [editor in chief Zoran Popović]. - Novi Sad :
Balkan Wildlife Scientific Society, 2014. - 1 elektronski
optički disk (CD-ROM) : tekst, slika ; 12 cm

Nasl. sa naslovnog ekrana. - Tiraž 90. - Bibliografija uz

svaki rad.

ISBN 978-86-7520-302-5

a) Ловство - Одрживи развој - Зборници b) Дивљач -

Гајење - Зборници
COBISS.SR-ID 289684231

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Ministry of Agriculture and
Environmental Protection



Ministry of Education, Science and
Technological Development

