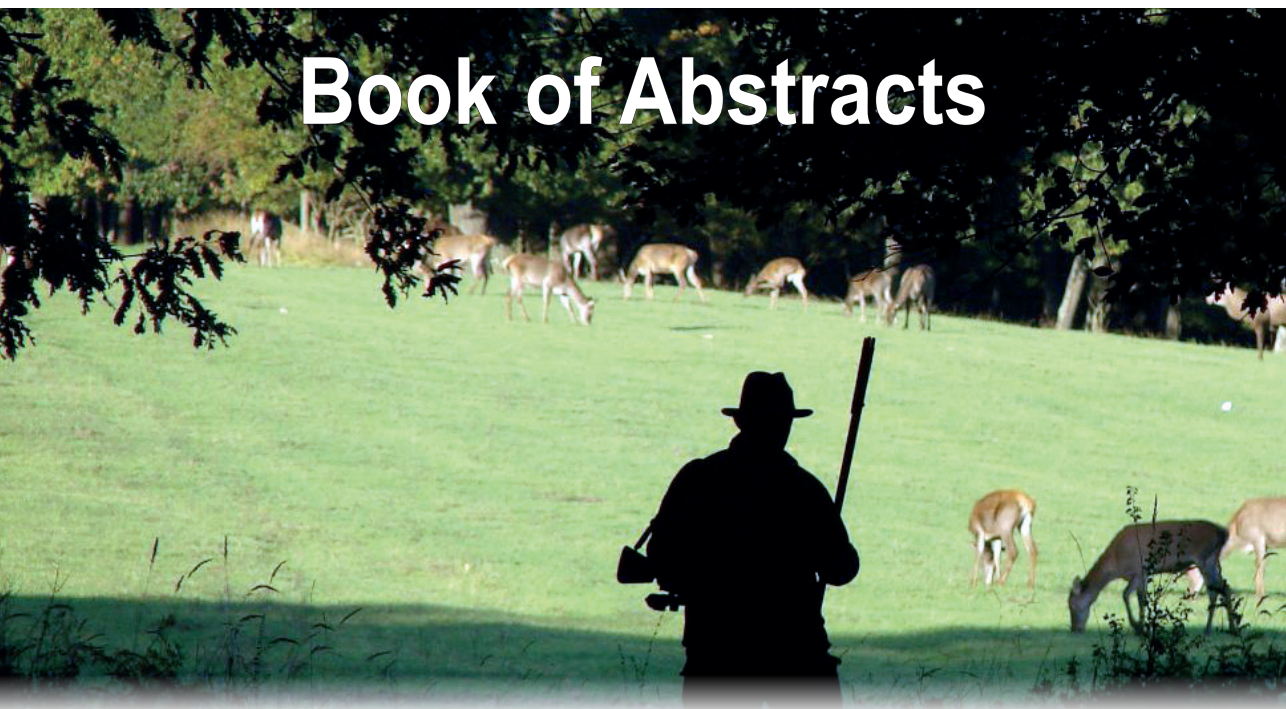




Modern Aspects of Sustainable Management of Game Populations

13 – 16 June 2018, Sofia, Bulgaria

Book of Abstracts



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ЮЖНОЦЕНТРАЛНО ДЪРЖАВНО
ПРЕДПРИЯТИЕ, ГР. СМОЛЯН

**6th International Wildlife and
Game Management Symposium**

**Modern Aspects of Sustainable Management
of Game Populations**

13 – 16 June 2018, Sofia, Bulgaria

Book of Abstracts

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**Dear colleagues and guests
of the Sixth International conference
“Modern aspects of sustainable
management of game populations”,**

It is a pleasure to share with you that the current conference is an expression of the multilateral scientific and practical work of our Department of Wildlife Management. It is an indication of following and developing of the academic traditions.

This conference takes place every two years and it has established itself as one of the leading events in Europe in this scientific and applied domain. The significant

interest to the conference is confirmed by the declared participation of more than 50 researchers from 14 countries. The conference will be under the patronage of the Minister of Agriculture, Food and Forestry of Bulgaria – Mr. Rumen Porodzanov – and is organized with the active participation of State Forest Enterprises, Executive Forest Agency, and Union of the Hunters and Anglers in Bulgaria.

University of Forestry is the only one in Bulgaria training Bachelors, Masters, and PhD students in the field of game and wildlife management. The Department of Wildlife Management is widely known with its professors and researchers like Prof. Metodi Ruskov, Prof. Nikola Botev, Prof. Ivan Kolev, Prof. Nino Ninov, Assoc. Prof. Hristo Mihaylov. The investigations, publications, monographs and books written by the authors from the department and focusing on the biology and ecology of the Red deer, Roe deer, Fallow-deer, Chamois, Golden Jackal, Brown Hare, Capercaillie, Pheasants, Quail and many other representatives of wildlife fauna, have gained international attention and recognition.

The department has been the main initiator and organizer of many international events, like hunting exhibitions, educational courses, workshops and conferences. In 1981 in Plovdiv, Bulgaria was organized the 3rd World Hunting exhibition, which is considered by the experts as the most significant in the history. In 1995 our Wildlife Management Department was host to the 22nd Congress of International Union of Game Biologists. Bulgaria is one of the leading countries in the world in the field of modern game management.

I believe that the discussions during the conference will put on accent to the traditions and novelties in the game and wildlife management science.

On behalf of the Academic Governing Body of our University and personally on my behalf I wish you successful work, useful discussions and meetings of all participants of the conference. In spite of the troubles, problems and challenges you face, in spite of the difficult time for the science, I wish you a lot of health, energy and perseverance for achieving of the high goals you have.

*Professor Ivan Iliev, DSc.
Rector of the University of Forestry
Sofia, Bulgaria*

**Dear participants,
Dear guests of the 6th international Wildlife
& Game Management Symposium,
Dear ladies and gentlemen,
dear colleagues,**



On behalf of the Organizing Committee I sincerely welcome you in Bulgaria and at the University of Forestry. It is our honor and we are proud to welcome and provide the traditional Bulgarian hospitality to over 50 scientists and guests from 14 countries. We are constantly expanding the geography and scientific scope of our conference and this indicates its importance today.

And this is a guarantee that this forum has its important role in solving serious problems and tasks for the conservation, management and sustainable use of game resources.

Bulgarian nature, species richness and numerous game populations are well known and unique. Bulgaria is a famous hunting destination. And this should be acknowledged to the scientists and researchers from Wildlife Management Department at the University of Forestry, your hosts. Along with the well trained and qualified Game managers and Foresters, today we enjoy a great diversity of wildlife in well preserved natural habitats and wise and sustainable use of game resources with the highest quality. We are convinced of the need for joint scientific projects and solutions because the game does not recognize boundaries.

Dear colleagues,

We hope and believe in following days we will share valuable experience and scientific results, we will enjoy pleasant and unforgettable moments and continue the noble and difficult mission to help the wildlife, nature and society.

Welcome, have a great time and good luck!

Assoc. Prof. Dr. Hristo Mihaylov

PROGRAMME – ABSTRACT TITLES

Thursday, 14th June, 2018
Sofia, University of Forestry, Aula

09:00 AM	REGISTRATION
11:00 AM	OPENING CEREMONY
PLENARY SESSION	
11:30 AM	STATUS AND MANAGEMENT OF LARGE CARNIVORES IN THE ALPS <i>Klaus Hackländer</i>
12:00 PM	MOLECULAR GENETICS AND HUNTING MANAGEMENT <i>Franz Suchentrunk, Steve Smith</i>
12:30 PM	GAME HEALTH IN ECOLOGY AND WILDLIFE MANAGEMENT <i>Tornsten Mörner</i>
1:00 PM	WILL THE QUAIL SURVIVE? <i>Hristo Mihaylov, Stoyan Stoyanov, Gradimir Gruychev, Natalia Koleva</i>
1:20 PM	LUNCH
WILDLIFE BIOLOGY AND ECOLOGY	
2:30 PM	COMPETITION, COEXISTENCE OR EXCLUSION? DISTRIBUTION OF EXPANDING GOLDEN JACKAL IN RELATION TO DISTRIBUTION AND DENSITY OF TWO OTHER CANID SPECIES, GREY WOLF AND RED FOX IN SLOVENIA <i>Hubert Potočník, Ivan Kos, Katarina Flajšman, Boštjan Pokorny</i>
2:45 PM	FEEDING HABITS OF URBAN WILD BOAR IN BUDAPEST, HUNGARY <i>Krisztián Katona, Anna Erzsébet Lakatos, Mihály Márton, László Szabó, Adrienn Csókás, Sándor Csányi, Miklós Heltai</i>
3:00 PM	MORE FEMALES OR MORE MALES? AGE-RELATED SEX RATIO OF THREE SPECIES OF WILD UNGULATES IN SLOVENIA <i>Katarina Flajšman, Ida Jelenko Turinek, Ivan Kos, Hubert Potočník, Boštjan Pokorny</i>
3:15 PM	QUANTITATIVE ANALYSIS OF SPATIAL-TEMPORAL DYNAMICS OF HUNTING MAMMALS IN RUSSIAN MIDDLE AMUR AREA <i>Oksana Revutskaya, Denis Fetisov, Efim Frisman</i>
3:30 PM	A LIFE AFTER HARVESTING: WHY THE POPULATION OF THE NORTHERN FUR SEALS (<i>CALLORHINUS URSINUS</i>) OF TYULENIY ISLAND DOES NOT RECOVER FOLLOWING THE HARVEST BAN? <i>Oksana Zhdanova, Alexey Kuzin, Efim Frisman</i>
3:45 PM	THE MOVING PATTERN AND SHORT-TERM SURVIVAL OF HOODED CROW (<i>CORVUS CORNIX LINNAEUS</i> , 1758) IN AN URBAN ENVIRONMENT <i>László Kövér, Petra Paládi, Szabolcs Lengyel, Lajos Juhász</i>
4:00 PM	DEPARTURE TO YUNDOLA

Friday, 15th June, 2018
Yundola, Conference Hall

GAME MANAGEMENT	
09:00 AM	HABITAT-USE OF THE BROWN HARE (<i>LEPUS EUROPAEUS</i>) IN AN AGRICULTURAL ENVIRONMENT <i>Norbert Keller, Nikolett Ujhegyi, Zsolt Biro, László Szemethy, Zsombor Farsang</i>
09:15 AM	ESTIMATION OF BROWN HARE (<i>LEPUS EUROPAEUS</i>) ABUNDANCE <i>Vukan Lavadinović, Dragan Stanojević, Stefan Stepić, Nevena Veličković</i>
09:30 AM	MONITORING OF PESTICIDE IN BROWN HARE ADIPOSE TISSUE IN ONE HUNTING GROUND OF VOJVODINA, SERBIA <i>Dejan Beuković, Miloš Beuković, Vojislava Bursić, Zoran Popović, Vukan Lavadinović</i>
09:45 AM	DEVELOPMENT OF BROWN HARE (<i>LEPUS EUROPAEUS</i>) POPULATION PARAMETERS IN SLOVAKIA <i>Jaroslav Slamečka, Tomáš Sládeček, Rastislav Jurčík, Ľubomír Ondruška</i>
10:00 AM	GIS METHOD FOR VEGETATION EVALUATION IN HUNTING GROUND <i>Milutin Kovacevic, Vladimir Markovic, Igor Ponjiger</i>
10:15 AM	PHEASANT (<i>PHASIANUS COLCHICUS</i>) GAME MANAGEMENT IN SERBIA <i>Vukan Lavadinović, Zoran Popović, Dejan Beuković, Milorad Danilović, Vladimir Maletić</i>
10:30 AM	RECOVERY PROGRAM OF THE ROCK PARTRIDGE (<i>ALECTORIS GRAECA GRAECA</i> MEISNER, 1804) IN THE "VRACHANSKI BALKAN" NATURE PARK (NW BULGARIA) – PRELIMINARY RESULTS <i>Hristo Mihaylov, Gradimir Gruychev, Stoyan Stoyanov, Evlogi Angelov, Nikolay Nenchev</i>
10:45 AM	WILL GLOBAL CHANGE AFFECT ALPINE CHAMOIS POPULATIONS ON THE ALPS? <i>Marco Apollonio, Roberta Chirichella, Tom Mason, Philip Stephens</i>
11:00 AM	COFFEE BREAK
11:30 AM	POPULATION DENSITY AND NUMBER OF RED DEER (<i>CERVUS ELAPHUS</i>) ESTIMATED BY SAMPLING PLOTS IN SOUTH-WESTERN POLAND <i>Bogusław Bobek, Jakub Furtek, Marta Wojciuch-Płoskonka</i>
11:45 AM	RED DEER POPULATION DENSITY AND CARRYING CAPACITY IN CENTRAL BALKAN MOUNTAIN FORESTS <i>Stoyan Stoyanov, Hristo Mihaylov, Plamen Tihov</i>
12:00 PM	PRELIMINARY RESULTS FROM USING OF A NEW METHOD FOR BULGARIA FOR DETERMINATION OF THE ACCURATE AGE OF RED DEER (<i>CERVUS ELAPHUS</i> L.) AFTER SHOOTING <i>Chavdar Zhelev, Frozita Ahmakova, Atidzhe Ahmed, Damyan Damyanov</i>
12:15 PM	WILD BOAR POPULATION SIZES REPORTED BY HUNTERS: ARE THEY BE INDEXES OF HUNTING SUCCESS? <i>Sandor Csanyi, Mihály Márton</i>

12:30 PM	ALIEN MAMMALIAN GAME SPECIES IN SLOVENIA: STATUS, MANAGEMENT AND PERSPECTIVES <i>Boštjan Pokorny, Ivan Kos, Hubert Potočnik, Katarina Flajšman</i>
12:45 PM	EFFECT OF AGE-SPECIFIC HARVESTING ON LIMITED STRUCTURED POPULATION <i>Galina Neverova, Efim Frisman</i>
1:00 PM	DYNAMICS OF THE WILD BOAR'S (<i>SUS SCROFA</i> L.) STOCK AND HUNTING BAG ON THE TERRITORY OF SOUTHWESTERN STATE FOREST ENTERPRISE IN BULGARIA <i>Damyan Damyanov, Rosen Andreev, Atidzhe Ahmed, Chavdar Zhelev</i>
1:15 PM	LUNCH
GAME GENETICS	
2:30 PM	GENETIC CHARACTERISTIC IN THE EUROPEAN BISON (<i>BISON BONASUS</i>) POPULATION FROM LITHUANIA <i>Algimantas Paulauskas, Loreta Griciuvienė, Irma Ražanskė, Rytas Papšys, Algimantas Lūža</i>
2:45 PM	CAN THE RIVER ACT AS GENETIC BARRIER FOR ALPINE CHAMOIS POPULATION? <i>Andrea Rezić, Toni Safner, Elena Buzan, Sandra Potušek, Nikica Šprem</i>
3:00 PM	PHYLOGEOGRAPHY OF BROWN HARES – CLOSING THE GAP BETWEEN THE BALKANS AND ANATOLIA? <i>Yasin Demirbaş, Milomir Stefanovic, Ayça Özkan Koca, Franz Suchentrunk</i>
3:15 PM	EUROPEAN ROE DEER (<i>CAPREOLUS CAPREOLUS</i>) – HISTORY WRITTEN IN MITOCHONDRIAL DNA <i>Kamila Plis, Magdalena Niedziałkowska, Bogumiła Jędrzejewska</i>
GAME DISEASES	
3:30 PM	MOLECULAR IDENTIFICATION OF <i>BARTONELLA</i> SPP. IN FREE-RANGING CERVIDS AND DEER KEDS (<i>LIPOPTENA CERVI</i>) FROM NORWAY <i>Irma Razanske, Olav Rosef, Jana Radzijeuskaja, Kamile Klepeckienė, Indre Lipatova, Algimantas Paulauskas</i>
3:45 PM	COMMON PHEASANT AS POTENTIAL RESERVOIR OF WEST NILE VIRUS <i>Milutin Djordjević, Branislav Pešić, Dragana Despot</i>
4:00 PM	COFFEE BREAK & POSTER SESSION
6:00 PM	CLOSING CEREMONY
8:00 PM	GALA DINNER

Saturday, 16th June, 2018

8:00 AM	BREAKFAST
8:30 AM	FIELD TRIP TO PIRIN NATIONAL PARK
4:00 PM	RETURN BACK TO SOFIA AND DEPARTURES

PLENARY SESSION

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STATUS AND MANAGEMENT OF LARGE CARNIVORES IN THE ALPS

Klaus Hackländer

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Corresponding author: Klaus Hackländer, e-mail: klaus.hacklaender@boku.ac.at

Abstract

Across the Alps numbers of brown bear, lynx and wolf increased in the recent decades. Estimated numbers from 2014 sum up to about 45 – 50 bears, 130 lynx and 160 wolves. Especially wolves are increasing rapidly with population growth rates between 30 and 50% and are a matter of concern for various land users, e.g. livestock farmers. For example, the first pack in Switzerland was established in 2012 in the canton Grisons. In 2017 already 92 sheep and goats had been killed by wolf in the canton despite intensive prevention measures. On the other side, hunters claim direct and indirect negative effects of wolf on game species. In Austria, the first reproducing wolf couple was detected in 2016. Within the home range of the pack, mouflon got nearly extirpated and hunting on red deer and wild boar got more difficult due to changes in group size and space use. To decrease conflicts, authorities fund protective measures (e.g. dogs, fences) and allow the killing of nuisance individuals. In countries with high conflict levels measures to regulate the population have been implemented. In this presentation, the measures for damage prevention and compensation are described for France, Italy, Switzerland and Austria. Differences between large carnivore management between the countries are discussed. Finally, I will emphasize the need for an Alpine-wide management including monitoring.

Keywords: *Ursus arctos, Lynx lynx, Canis lupus, damage prevention, damage compensation*

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MOLECULAR GENETICS AND HUNTING MANAGEMENT

Franz Suchentrunk, Steve Smith

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Abstract

Nowadays, many molecular genetic markers and elaborated statistical procedures are available that can assist resolving very specific questions in wildlife conservation and hunting management. However, whereas genetic analyses in the context of wildlife conservation issues have in the last 25 years or so lead to “Conservation Genetics”, a highly developed field of research that combines theoretical and applied approaches to various biological conservation issues, the usage of genetic data for hunting planning and decisions is by far not that popular. Major questions of specific hunting planning and decisions that can be addressed by genetic approaches utilizing samples of dead game species or non-invasive samples of dead or alive animals (biological trace samples such as hair, blood, saliva, urine) concern both the population and the individual level. They are related to the spatiotemporal population or individual scales and address issues, such as population delineation (natural hunting management units), spatial substructure, population size (density), migration patterns (immigration/emigration rates), genetic diversity and inbreeding effects on population viability and trophy development, legal or illegal introduction of (exotic) game and subsequent introgression into autochthonous populations, hybridization of wild specimens with their domesticated forms, game translocation and naturalization in the course of restocking operations, genetic population changes due to trophy hunting, and individual identification e.g., related to trophy cheating. We will present a number of examples mainly from our own work particularly for red deer (*Cervus elaphus*), Northern Chamois (*Rupicapra rupicapra*), wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), brown hare (*Lepus europaeus*), mountain hare (*Lepus timidus*), gray wolf (*Canis lupus*), European polecat (*Mustela putorius*) and steppe polecat (*Mustela eversmannii*), black grouse (*Tetrao tetrix*), and grey partridge (*Perdix perdix*).

Keywords: *molecular genetics, game management, genetic variability, inbreeding, introgression, population size, migration*

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GAME HEALTH IN ECOLOGY AND WILDLIFE MANAGEMENT

Torsten Mörner

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National Veterinary Institute, Uppsala, Sweden

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Abstract

In many animal populations there is a balance between reproduction and mortality, and if so the population number will be stable. Positive factors for a population are access to food and water of good quality, suitable habitat, good climatic conditions, limited number of predators and freedom from pathogens. Increased mortality can occur when one or more of these factors fail. Causes of mortality include predation, starvation, traumatic injuries, infectious and non-infectious diseases, intoxication and deficiency diseases. Factors of importance are also the numbers of animals contracting a disease (morbidity) or number of animals dying from a disease (mortality). The population density also plays an important role for how seriously a disease outbreak will affect a population. Some diseases in wildlife occurs only in wildlife, other are transmissible between wildlife and domestic animals, and some are transmissible between animals and humans (zoonoses). More than sixty per cent of infectious diseases in humans are zoonoses, with a majority of them with wildlife as a reservoir. Many diseases with high morbidity and mortality can reduce an animal population significantly, but hardly ever cause one hundred per cent mortality. In a long-term perspective, evolution leads to the fact that a disease affected animal population and the pathogen that caused the disease, adapts to each other and mortality falls to a low level. Despite this can some diseases in wildlife have a great impact on biological diversity and change the whole ecological system. Climate change can also contribute to dramatic ecological effects on animal populations with introduction of new diseases. Sometimes there is a need to manage wildlife diseases to avoid spread to domestic animals or humans, and this can be done by reducing animal populations, reduce disease vector populations or vaccination of wildlife.

Key words: *Game health, diseases, mortality, morbidity, ecology*

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WILL THE QUAIL SURVIVE?

Hristo Mihaylov¹, Stoyan Stoyanov¹, Gradimir Gruychev¹, Natalia Koleva²

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Abstract

The Quail population size has dramatically decreased in the last 10 years. According to personal observations and hunters' questionnaires the quail hunting bags declined at least 5 times considering the same hunting pressure and catch effort. Potential threats driving such decline could be found in the whole range as the quail is migratory species. In search of the answers the breeding density of quail was studied in Western Bulgaria during May-June in 2014 – 2017 by using point counts (Bibby *et al.* 1992). The male song was used as indicator. The breeding density in May was 0.3 singing males/10 ha, while in the same areas in the beginning of 1990's it was 1.85 singing males/10 ha in May and 2.81 singing males/10 ha in June (Mihaylov 1995).

The fluttering chicks in the broods were counted after the harvest of cereals in July and August. Chicks can flutter from ground at 14 days and fly confidently at 3 weeks, and the broods separate at 5 weeks (Seint-Jalme 1990). The results were compared to the data received by using the same methods and in the same areas (Mihaylov 1995). Only 4.04 chicks per brood survive on average compared to 5.46 in 1990's ($\chi^2 = 5.6886$, $df = 1$, $p = 0.017$).

In August and September the food of quail during the pre-migration period was analyzed. The data showed significant change ($F_{pseudo} = 6.2885$, $df = 1$, 420 , $p = 0.0001$) in the diet and food preferences compared to 1988-1990 (Mihaylov 1995). The quantity of food in the crops was identical but the weeds share in the quail diet in pre-migration period has decreased from 71.13% to 34.45%. The total of 38 plant species were found in the food in 1988 – 1990, while in 2017 only 7 plant species were present, including cereals – wheat (*Triticum sp.*), oat (*Avena sp.*) and sunflower (*Helianthus annuus*). From the three weed species occurring with more than 10% frequency in the diet 30 years ago – field larkspur (*Consolida regalis*), knapweeds (*Centaurea sp.*) and barnyard grass (*Echinochloa crus-galli*), only the last one was found, with frequency of occurrence below 10%. The main reason for this dramatic change was the use of total herbicides which have led to a reduction on the availability of weeds.

The results showed also breeding density decline in Western Bulgaria, decrease of chicks' survival rates and population growth rates. A major contribution to this is the modern farming which has led to loss of the habitats quality, very poor food availability and lack of shelters and hides, such as rough grass and uncultivated land. In the whole range continues hunting with nets during migration although hard to be proven. The use of prohibited by Bern Convention and Habitats Directive (92/43/EEC) means and methods of hunting such as electronic devices and tape recorders is still common practice in Bulgaria. Derogations of Bird Directive (2009/147/EC) are also common. Hence the common quail survival is not only national, but transboundary issue, and it is time for real and working international cooperation for the future of this species.

Key words: quail, *Coturnix coturnix*, breeding density, chicks' survival, feeding, modern farming

ORAL SESSION

6th International Wildlife and Game Management Symposium
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COMPETITION, COEXISTENCE OR EXCLUSION? DISTRIBUTION OF EXPANDING GOLDEN JACKAL IN RELATION TO DISTRIBUTION AND DENSITY OF TWO OTHER CANID SPECIES, GREY WOLF AND RED FOX, IN SLOVENIA

Hubert Potočnik¹, Ivan Kos¹, Katarina Flajšman³, Boštjan Pokorny²

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Abstract

During the last decades, the golden jackal (*Canis aureus*) population in SE Europe has expanded across the Balkan and also into Central, E- and N Europe. The species is highly adapted to thrive in human-dominated landscapes where it takes advantage of human presence and abundant food sources. These, together with changes in land use, prey/predator abundance, and climate, have likely facilitated the expansion. The spread of the jackal has raised numerous management issues, while the emerging ecological role of the species in the areas of recent range expansion is barely known. In competition, species evolve either to avoid each other, to tolerate the other, or to exclude the other. Interference competition with wolves (*C. lupus*) is hypothesized to be one of factors that have limited the expansion of jackals to Europe. The eradication of wolves is often invoked to explain the expansion in jackal range throughout much of Central- and SE Europe. Spreading of the areal is followed by a rapid increase in abundance of jackals. A similar trend is significant also for Slovenia, where its range overlaps with the ranges of two other canid species, the grey wolf and the red fox (*V. vulpes*). The current evidence for interspecific competition between these two canids is mostly circumstantial, however previous studies indicated that effects can be either direct and/or indirect. Interspecific nutrition studies with the sympatric red fox indicate strong food niche overlap between the two canids. In some areas of recent jackal's range expansion strong competition between jackals and red foxes has also been indicated indirectly, by remarkable declines in red fox harvest. All data on wolf's and jackal's distributions in Slovenia were collected from the national monitoring databases. For the red fox, data on relative abundances were taken from the hunting records and compared to jackal distribution. We examined the extent of spatial segregation of wolves and jackals by evaluating estimated distribution overlap between resident wolves and recent distribution of jackals. Overlapping distributions of the three species indicate: (1) that jackal's current distribution in Slovenia is barely overlapping with resident wolf territories, however jackals are present primarily on their edges and between their territories, (2) jackals' distribution 100% overlaps with high density fox areas, but 10-year trend in red fox harvest in these areas has not shown any decline in their abundance yet.

Keywords: golden jackal, competition, distribution overlapping, grey wolf, red fox

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FEEDING HABITS OF URBAN WILD BOAR IN BUDAPEST, HUNGARY

**Krisztián Katona, Erzsébet Anna Lakatos, Mihály Márton, László Szabó,
Adrienn Csókás, Sándor Csányi, Miklós Heltai**

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Abstract

Wild boar (*Sus scrofa*) populations have continuously increased throughout Europe over the past decades. It is also present in many large cities in Europe, which requires a proper management of the species and its habitat in a special environment. Investigation of the feeding habits of urbanised wild boar individuals is fundamental for the reduction of the species-related conflicts.

In our study, we described the diet composition of wild boar in the capital of Hungary, within the administrative area of Budapest. Stomachs ($n = 62$) were collected between 2012 and 2014 at any time of the year, and between May 2016 to April 2017 from hunted wild boars.

According to our results, the weight of total stomach content ranged from 0 to 4500 g. The number of food categories in the individual diet was 2.66 ± 1.32 . The diet was dominated by plant materials in both periods ($76.5 \pm 31\%$ and $92.5 \pm 27.5\%$, respectively). Among them we found the roots of monocots, grasses, tussocks, herbaceous shoots and roots, oak and willow leaves and other dry leaves, corn, greenage and cherry seeds, chestnut and oak acorn. The proportion of acorn ($22 \pm 32\%$ and $55.5 \pm 48.5\%$) and maize ($19.5 \pm 33\%$ and $31 \pm 47.5\%$) was outstanding in the diet. The presence of monocots in the diet was $17 \pm 26.5\%$ and $0.2 \pm 0.85\%$. Beside that, the consumption of the grass species of the lawn was also $11 \pm 30\%$ and $16.5 \pm 4.5\%$. The proportion of the fruits was $4 \pm 16.5\%$ and $0.2 \pm 0.85\%$; meanwhile the feed of animal origin reached $2 \pm 8.5\%$ and $0.01 \pm 0.05\%$ (caterpillars, earthworms, snails). Garbage consumption was rare (fur of domestic rabbits, pieces of bread, foil). We detected dietary differences between the sexes and age classes. The proportion of the acorn was higher in case of sows than in adult males (48 vs. 24% and 64.5 vs. 50%). The proportion of the acorn was higher in the diet of adults than in juveniles (45.5 vs. 24.5% and 56 vs. 35%). However, fewer adults consumed corn than young individuals (40 vs. 64.5% or 28.5 vs. 50%). The appearance of wild boar in cities is a natural phenomenon, which should be treated continuously. Urban wild boar survival is significantly enhanced by the availability of their natural food, maize consumed at the baiting site and the managed lawn. In order to reduce the urban wild boar populations, the adequate management of urban habitats by reducing food sources and hiding-places, moreover the regional control of wild boar population are necessary.

Keywords: *Sus scrofa*, diet composition, acorn, baiting, garbage

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**MORE FEMALES OR MORE MALES? AGE-RELATED SEX RATIO
OF THREE SPECIES OF WILD UNGULATES IN SLOVENIA**

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Abstract

The primary sex ratio, i.e. sex ratio of fetuses of all species which produce offspring through sexual reproduction, is according to Fisher's principle, close to 1:1. However, many studies on sex-allocation have shown that various factors (e.g. body condition of females, nutrition and weather conditions) can influence the sex ratio of offspring either before birth (and hence influencing secondary sex ratio) or during the neonatal mortality. Consequently, with the age of animals the sex ratio becomes skewed due to higher mortality of certain sex. Therefore, in mammals, particularly in polygamous species, adult sex ratio is typically female-biased, while in birds it is male-biased.

The information on sex ratio is especially important in case of game species in which we can affect demographic structure by management actions: based on information on sex ratios wildlife managers are able to make more efficient management plans which are in accordance with the demographic structure as well as with natural population dynamics of those species.

We studied sex ratio of three important game species of wild ungulates: roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*) in Slovenia. The study was performed in two ways, i.e. by analysing the sex ratio of: (i) fetuses in harvested or in road-killed females (primary sex ratio), (ii) road-killed animals of different age classes (offspring, yearlings, adults)(secondary sex ratio). The results of fetus analysis did not show any signs of sex-allocation towards certain sex neither in roe deer nor in red deer: in both species, sex ratio of fetuses was 0.9:1 in favour of males. On the contrary, in wild boar the primary sex ratio was 1:0.7 in favour of females. However, with the age sex ratio changes towards female-skewed ratio in all species: for example, in roe deer annual sex ratio (F:M) of all road-mortality cases registered in Slovenia in the period 2010 – 2016 was from 1.04:1 – 1.25:1 in fawns, 0.90:1 – 1.18:1 in yearlings, and 1.70:1 – 2.83:1 in adults, respectively. In the contribution, we will discuss the reasons for female-biased trends with ageing of these three wild ungulate species as well as some management implications.

Keywords: sex ratio, roe deer, red deer, wild boar, road mortality

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**QUANTITATIVE ANALYSIS OF SPATIAL-TEMPORAL DYNAMICS
OF HUNTING MAMMALS IN RUSSIAN MIDDLE AMUR AREA**

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Abstract

Objective(s): Two purposes of the study are (i) a quantitative analysis of the long-term registration data for the population size of hunting mammals (elk, Manchurian deer, wild boar, roe deer, squirrel, sable) in Russian Middle Amur area; (ii) analysis of mammals' distribution on habitat structure of the region.

Methods: The mathematical modeling method was applied for the quantitative analysis of changes in the population numbers. To identify the relationship between the spatial distribution of hunting animals and the habitat characteristics we have used correlation and regression analysis.

Results: The study showed that when a certain stability of the total number of game animals throughout Russian Middle Amur area from the mid 90s of the last century indicates a steady downward trend in population numbers, especially in areas where hunting occurs. Some stability of population dynamics is related to the situation of animals in nature reserves. It is shown that the spatial distribution of animals depends not only on their typical habitats location and size, but also an average size of habitat patches and their landscape divisibility. The high density of elk, red deer, and wild boar is due to the location of the coniferous – broad-leaved and oak forests. The densities of squirrels and sables are greatest wherever coniferous and coniferous-broad-leaved forests predominate in the area. The high density of ungulates also is due to the presence of large forest patches. With growth of the area of oak forests and agricultural lands and fragmentation of shrub-grown meadows the density of roe deer increases. Moreover, it was shown that the highest densities of ungulates are recorded in nature reserves.

Conclusion: It is shown that in distribution of the population of hunting mammals in Russian Middle Amur area the important role is played not only by differences in the natural conditions of habitats, but also by the conservation status of the territory.

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Keywords: *game abundance, spatial-temporal dynamics, habitat, quantitative methods*

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A LIFE AFTER HARVESTING: WHY THE POPULATION OF THE NORTHERN FUR SEALS (*CALLORHINUS URSINUS*) OF TYULENIY ISLAND DOES NOT RECOVER FOLLOWING THE HARVEST BAN?

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Abstract

Following many years of managed harvest, the population of Northern fur seal on Tyuleniy Island (Sea of Okhotsk, Russian Far East) appeared to be depressed. The harvest was first significantly limited, and then banned altogether. However, the birth rates have never recovered.

We perform the estimation and analysis of survival rates of different sex and age groups of the population to elucidate the underlying changes in intra-population dynamics. We also analyze an average reproductive success of the northern fur seal bulls and their age structure to reveal the effect of harvest on the reproductive potential of the population. Methods: Mathematical modeling, numerical simulations and multivariate statistical technique.

The data set consists of the estimated numbers of adult males and pups in the rookery along with the exact numbers and ages of harvested animals; and sea sample data of females. Results and conclusions: Our investigation shows that the unexpectedly slow growth of the population most likely is not caused by an abrupt decline of survival rates of any age- and sex-groups. There is no substantial change in juvenile survival, and older animals' survival rates are actually increasing. However, the analysis of density-dependent factors of juvenile survival demonstrates significant increase in intra-species competition. Also, the dynamics of pups' viability is telling: it was the highest at the beginning of the period of observations, and then it sharply decreased following intensification of harvest, and finally started growing again in response to strong conservation measures, but never achieved its original level. We obtained an enough convincing evidence to proof the hypothesis that the harvest was selective, i.e. the most potentially productive males were hunted. It led to a significant rearrangement of the population age structure and a sharp slowdown in population growth, even against a background of a slight increase in the natural survival of almost all age groups. Further growth in the population of the northern fur seal, if any, will not be some kind of rapid. For its acceleration a new natural arrangement of population structure is necessary, i.e. an increase in population quality and a share of bulls with high reproductive success.

This work is partially supported by the Russian Foundation for Basic Research (Project no. 18-04-00073) and the Fundamental Research Complex Program of FEB RAS "Far East".

Keywords: *Callorhinus ursinus, mathematical modeling, harvest, conservation*

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**THE MOVING PATTERN AND SHORT-TERM SURVIVAL OF HOODED CROW
(*CORVUS CORNIX* LINNAEUS, 1758) IN AN URBAN ENVIRONMENT**

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Abstract

Urban wildlife management handles all wildlife species occurring in cities. Its tasks includes: carrying out different kinds of research, solving conflicts between animals and humans and informing people about urban species, and how to live together with them without any confrontation. Hooded Crow occurs in urban environment very often, its population is growing in several cities in Hungary as well. Crows' significant population growth causes several problems both in urban avifauna (nest predation) and also for the human (aggression). Reflecting this, it is conceivable that their urban population control will be necessary. However, before any kind of intervention, it is necessary to extensively study their behaviour and their ecological features as well. To learn more about the urban Hooded Crows motion patterns and area fidelity, we marked them with white wing-tags with unique black numbers written on them, and observed their movements around Debrecen on two different routes, six times a week. We collected 281 records from November 2016 to September 2017. Based on these data, we separated 6 different areas which were frequently used by crows. Most of these observations occurred at winter ($n = 174$), 75 records came from spring, and 32 from summer. The area from where feedbacks arrived also changed in time. In winter, it was 610 hectares. In spring 887 hectares, and in summer 768 hectares. Same applies to the size of home ranges; their median value was 29.2 hectares in winter, 5.1 hectares in spring, and 1.0 hectares in summer. Based on our results it is certain that permanent food sources are highly important for Hooded Crows, and it affects their motion patterns more than anything else. Out of 28 marked Hooded Crows we obtained data about 26 individuals. In case of 24 crows, we have more than one record. Survival of marked crows seems to be high, since only two deaths are certain. Our results help to understand the ecological features of Hooded Crows in an urban environment and can be used by urban wildlife management, nature conservation and city management as well.

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Keywords: Hooded Crow, *Corvus cornix*, urban environment, wing-tag, patagial-tag, trapping

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**HABITAT-USE OF THE BROWN HARE (*LEPUS EUROPAEUS*)
IN AN AGRICULTURAL ENVIRONMENT**

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Abstract

The brown hare (*Lepus europaeus*) is a keystone species in agro-ecosystems, food-source to several birds of prey, and indicates the state of agricultural habitats. Its population declines all over Europe, which is suspected to be caused by the negative outputs of the intensive methods of modern agriculture. In order to mitigate the negative trends, and establish strong habitat-development projects, the factors affecting its population must be determined. A telemetry-survey have been established by the Szent István University since 2015 in Jászágó, Hungary. At the beginning, seven specimens were live-captured and then three more in the next year. Ecotone Felis GPS-GSM collars were used to survey the home-range and habitat-use of the hares. The devices were set to collect 4 localization points per day. The localization points of each specimen were divided into seasonal (Winter/Summer) and daily (diurnal/nocturnal) groups. Seasonal vegetation-surveys were established in the research area, where the borders of field plots, field-margins and the overall vegetation were recorded. The habitat-preference of each specimen was calculated. During the spotlight surveys, the habitat preference was also calculated and it have been compared with the preference of the collared specimens. Our analysis couldn't prove significant preference on field-margins, although the density of localization points was fewer in the inner areas of the field plots. The use of field-margins depended on seasons, part of the day and the quality of the field margins as well. Contrary to our expectations, the preference of legumes was not high, and the specimens avoided grasslands too.

Keywords: brown hare, *Lepus europaeus*, agriculture, habitat-use

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ESTIMATION OF BROWN HARE (*LEPUS EUROPAEUS*) ABUNDANCE

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Abstract

The Brown Hare (*Lepus europaeus*) is one of the most abundant game species in Serbia, and as such very popular among hunters. Despite its importance, the Brown Hare abundance decreases and its number is below habitat potential. In order to re-establish the Brown Hare population size, management goals and practices need to be re-defined. However it is not possible without accurate estimation of population's size.

Aim of this research is to find a suitable practice for proper estimation of Brown Hare population in lowlands. In order to do so it tests several different census methods: the traditional driven census performed by hunters; spotlight census; and line and point transect census with thermal cameras. All census methods have been tested on four different lowland sample plots, which vary in land use or relief.

Preliminary results show that the easiest and the most accurate method to estimate Brown Hare population size is with thermal cameras from transects. Nevertheless this method is also the most expensive one.

Keywords: *Brown Hare, census, Serbia, preliminary results, thermal cameras*

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**MONITORING OF PESTICIDE IN BROWN HARE ADIPOSE TISSUE
IN ONE HUNTING GROUND OF VOJVODINA, SERBIA**

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Abstract

The Brown hare is one of the most abundant game species in Europe, as well as in Serbia. Good habitats for this species are at north part of Serbia, Vojvodina -province. Although the brown hare is a very adaptable species, but in recent years it faced with a declining numbers tendency, i.e. today's mosaic of factors that control the directions of the rise and fall of hare population are very complex as their interconnectedness. The anthropogenic factors like intensive agricultural production, with larger monocultures, use of new faster agri-machinery for land cultivation with wider operation mode and crop farming with inadequate and excessive use of products for plant preservation, can be one of the dangerous factors with long term negative impact. The analysis of the presence of pesticides in brown hare tissue was carried out in one hunting ground of (North west part of Vojvodina province, Serbia). The liquid chromatography – tandem mass spectrometry technique combined with the electrospray ionization, LC–MS/MS(ESI), was applied for the detection of 96 pesticides in European hare adipose tissue collected during 2013. and 2016. years. Within the validation the recoveries of extraction, it has been detected limits (LOD) and quantification limits (LOQ). Detected pesticide in 2013. year were: Carbendazim, Carbofuran, Cyprodinil, Diazinon, Fluroxypyr-methyl, Imidacloprid, Indoxacarb, Metalaxyl-M, Nicosulfuron, Propyconazol, Pyrimethanil, Trifloxystrobin. Detected pesticide in 2016. year were Ciprodinil Piperonil Butoxide, Piriproxifen Epoxykonazol. Significant higher presence pesticide in adipose tissue found during 2013. year. Most of deselected pesticide belongs to Fungicide group. In 2013. year recorded significant higher quantity of detected pesticide groups as well as the levels of detected pesticides compared to 2016. year. It can be related to the weather conditions that affected the use of pesticides in crop farming.

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Keywords: *brown hare, pesticide, adipose tissue, anthropogenic factors, Serbia*

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**DEVELOPMENT OF BROWN HARE (*LEPUS EUROPAEUS*)
POPULATION PARAMETERS IN SLOVAKIA**

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Abstract

In Slovakia, different developments are recorded in the populations of cloven-hoofed game and small game. The population of cloven-hoofed game is increasing and causing damage to its environment while the populations of small game are gradually decreasing. Brown hare is a traditional game species and the peak harvests in the 1970s were as high as 350 thousand animals. Since 2010, however, only approximately 15 thousand hares are harvested every year, which is 4.3% of the maximum. Whereas in years 1990 – 1995, 28.6% of spring stock was harvested, today it is only 8.8%. The decrease in population size is caused by insufficient population recruitment, which has been since 2010 approximately 42.3% (proportion of young hares in the bag). Recruitment is calculated as the proportion of young in the bag according to the dried eye lens weight. Recruitment is variable between years as well as between localities, which confirms the significant influence of the environment on successful reproduction and survival of young. In the localities with less favourable conditions, the recruitment is 19.3% in average, while in the localities with favourable conditions, it is as high as 63.3%. This is confirmed also by comparing the number of born leverets for each month. In the localities with favourable conditions, the number of born leverets culminates from May to June, while in the localities with less favourable conditions the number is low every month. The influence of predators is essential; the hare bag is negatively influenced by fox population ($r = -0.703$) as well as by wild boar ($r = -0.490$). The ecologisation programs within Europe's common agricultural policy have not yet had the desired effect on the increase in biodiversity. The deciding factor in maintaining the hare population is the development of favourable environmental conditions.

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Keywords: brown hare, *Lepus europaeus*, management, recruitment, Slovakia

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GIS METHOD FOR VEGETATION EVALUATION IN HUNTING GROUND

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Abstract

Recent researches have determined that vegetation is one of the essential factors for game habitat quality. Vegetation is important in the form of the following components: as a food supplier, as a shelter provider, as the creator and regulator of the micro-climate of the habitat, as well as a regulator of the amount of light. Past practice has shown that the classical methods for evaluating habitat factors as vegetation involve a lot of subjectivity and often leads to unrealistic determination of hunting ground capacity. Instead of the classical analyses, paper proposes assessment of this factor using Geographic Information System (GIS) which is widely applied in the many fields and activities and therefore in the field of hunting. Statistical analysis of vegetation is based on processing of satellite images of hunting ground. NDVI – normalized difference vegetation index is a graphical indicator that can be used to analyze images obtained by remote sensing and is used for these purposes. Researched area was hunting ground “Kapetanski rit” – Kanjiža, Serbia. In order to assess the vegetation factor, the analysis of satellite images is done for two periods of the year (May and December/January). In May the game prepares shelters because of bringing an offspring, so it is extremely important how much vegetation is present in the hunting ground. The period December/January is taken as part of the year when vegetation coverage is minimal due to winter, and since game is in need of additional food and shelter. Based on the obtained results and maps, the user of the hunting ground can have a clearer view of the vegetation types and distribution, as well as assistance in planning and analyzing the territorial distribution of the game. Comparing classical methods for evaluating vegetation and use of GIS for this purposes, obtained results indicate to advantages of new improved GIS methodology.

Keywords: GIS, hunting ground, vegetation, habitat evaluation, NDVI

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PHEASANT (*PHASIANUS COLCHICUS*) GAME MANAGEMENT IN SERBIA

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Abstract

Pheasant (*Phasianus colchicus*) is one of the most abundant game species in Republic of Serbia, despite it is allochthonous. As such it has great importance for Serbian hunting sector and is popular among hunters. Nevertheless there are critics that its abundance is decreasing and does not meet habitat potentials.

Aim of this research is to explore Pheasant management in Serbia at national and regional level. In order to do so it collects data from hunting grounds' management plans to estimate population abundance. Obtained data are compared with previous researches to identify population trend. Game management at regional level is analyzed by using an utilization coefficient, which is a ratio of game abundance before hunting season and realized hunting pressure. Besides this research includes social dimension, since the hunters were interviewed to evaluate Pheasant importance for them.

Results show that Pheasant abundance is slightly overabundant, but that its population number is in decrease. Utilization coefficients vary within the regions, which indicate that there are different hunting pressures on the population. Therefore the status of Pheasant in Serbia should be improved, since it is one of the most important game species for hunters.

Keywords: Pheasant, Serbia, game management, utilization coefficient, Human dimensions

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**FIRST RESEARCH AND RESULTS FROM SEMI NATURAL BREEDING
OF ROCK PARTRIDGE (*ALECTORIS GRAECA GRAECA* MEISNER, 1804)
IN BULGARIA**

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Abstract

In 2014, in the western part of Stara Planina Mountain, we build light demountable cage for raising Rock Partridge (*Alectoris graeca graeca* Meisner, 1804). The location of the cage falls within the natural range of the Rock Partridge. They were placed in typical habitats of the species. In each aviary with an area as about 300 square meters 4 males and 4 – 5 females were settled. Of a total of 73 nests surveyed for the entire study period in 22 (30.1%) of cases were unsuccessful nesting. In 54 cases, the bird chooses artificial nests or builds nests around the facilities of the aviary. In 19 cases they choose natural places for build nests. The average clutch size during the experimental period 2014 – 2017 was 8.4 ± 2.9 (2 – 13) (mean $\pm$ stdev. min-max). The hatchability was $74.3\% \pm 10.3\%$ (60 – 88.9%) ($n = 11$). Sixty-four percent (64.4 ± 4.3 ; 60 – 70%) of the hatchlings survive to 90 days of age.

The breeding success is similar that known in Rock Partridges in the wild. The average hatchability is higher than that established in the farm, but lower than in the wild. Semi natural breeding of Rock Partridge can be an alternative way of restoring the species in Bulgaria.

Key words: *Alectoris graeca graeca*, semi natural, clutch size, hatchability, hatchlings.

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**RECOVERY PROGRAM OF THE ROCK PARTRIDGE (*Alectoris graeca graeca* MEISNER, 1804) IN THE “VRACHANSKI BALKAN” NATURE PARK
(NW BULGARIA) – PRELIMINARY RESULTS**

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Abstract

The Rock Partridge (*Alectoris graeca* Meisner, 1804) is endemic to Europe, occurring only in the Alps, the Apennines, Sicily and the Balkans. It is suspected to be declining moderately rapidly, particularly in the Balkans which hold a substantial proportion of the species population and range, based on a balanced assessment of the available evidence (Griffin 2011, Birdlife International 2017). Survival rates of 50 released rock partridges in typical habitats in the “Vrachanski Balkan” Nature Park were studied during the reintroduction program. The birds were about 150 days old. Almost all released birds were monitored for 110 days. Twenty of them were marked with radio transmitters, which allowed to be determined birds survival rate, dispersion and habitat preferences. Birds mortality reached 70% at the end of survey period and only 6 (30%) of them survived and bred in the next spring. Most birds (65%) died in the first month after release due to predation. The main predators were mammals while the raptors caused an insignificant part of mortality. In cold winter days with temperatures lower than -25°C only one dead bird was found. The survival rates of rock partridges did not depend on sex ($\chi^2 = 0.05$, $p = 0.82$, $df = 1$) nor on age of birds ($\chi^2 = 0.1$, $p = 0.9$, $df = 1$). The birds' dispersion varied from 35 m to 1.3 km. However only single birds moved more than 1 km away from the release point. Survival rates of birds raised in semi-natural environment are crucial for the success of the Rock Partridge recovery program in the “Vrachanski Balkan” Nature Park.

Key words: *Alectoris graeca graeca*, survival rates, mortality, radio telemetry

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WILL GLOBAL CHANGE AFFECT ALPINE CHAMOIS POPULATIONS ON THE ALPS?

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Abstract

From a study conducted in the Swiss Alps, that Alpine chamois activity rhythms proved to be strictly related to temperature and that the thermic interval when activity is higher was quite narrow. In the Gran Paradiso National Park (Italy) we showed that a variation in temperature exerted an influence over chamois behaviour. We found a strong evidence for an effect of temperature, independent of time of day, on both altitude use, and time spent foraging. On these basis, we aimed to investigate the impact of climate changes on the biology and demography of this species. So, we analysed the individual traits and the population parameters in Central-Eastern Alps (Trento province, Italy). In these areas, the analysis of eviscerated weights from yearlings regularly hunted in the past 35 years provided a negative trend with a significant decrease. Data revealed a strong evidence that increasing population density and warming temperatures during spring and summer were linked to the mass declines. At the same time, we analysed the demographic trends of these populations. We found that the productivity of the females evaluated as the ration between kids and females (NK/NF) didn't change but the ratio between females and yearlings (NY/NF) significantly decreased, resulting in lower annual population recruitment. Controlling by the NK/NF ratio recorded in the previous year, the most important negative factors to explain variation in population recruitment were the snow cover of the first winter experienced by kids and the maximum temperature of the vegetation growing season.

Our study pointed out that Alpine chamois population recruitments are affected by different climatic factors and food resources, suggesting difficult adaptation to the future climate changes. From the management point of view, it is clear that in such a situation a strong decrease in the share of yearling in the culling quotas is mandatory. This age class in fact is decreasing due to the poor capacity of kids to survive winter and to reach one year of age in an increasing temperature scenario.

Keywords: *Alpine chamois, global change, activity rhythms, temperature, population recruitment*

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**POPULATION DENSITY AND NUMBER OF RED DEER (*CERVUS ELAPHUS*)
ESTIMATED BY SAMPLING PLOTS IN SOUTH-WESTERN POLAND**

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Abstract

The objective of the study was to determine the density and population numbers of red deer in south-western Poland in forests of a total area of 550,300 hectares, administered by the Regional Directorate of State Forests in Wrocław. The red deer game management there is conducted in ten large management units whose forested areas range from 39,900 to 68,700 hectares. In January and February 2017, in all large management units, the taxation of red deer population numbers were conducted on large (300 – 500 hectares) sampling plots. On those plots, the red deer were counted by teams numbering 30 – 50 persons. The combined area of all sampling plots amounted to 68,800 hectares, i.e. 12.5% of the forested study area. In particular management units, the density of red deer individuals ranged from 29.5 individuals / 1000 hectares of forest in lowland large coniferous forest complexes (Bory Dolnoślaskie) to 117.6 individuals / 1000 hectares of forest in Kłodzka Valley (Sudety Mountains). The population number of red deer throughout the study area was estimated at 36,900 individuals, i.e. 67.1 animals / 1000 hectares of forest. According to the 10 years term management plan, in 2027 population size of red deer should be reduced to about 20,100 animals (36.5 animals / 1000 hectares of forest). Therefore, during 2017/18 hunting season, the harvest plan includes 9,500 animals.

Keywords: *red deer, sampling plots, population density, harvest plan, Poland*

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**RED DEER POPULATION DENSITY AND CARRYING CAPACITY
IN CENTRAL BALKAN MOUNTAIN FORESTS?**

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Abstract

The aim of sustainable wildlife management is to maintain wildlife populations at economically, socially and environmentally desirable levels. Central to this aim is the concept of carrying capacity. The economical carrying capacity should be defined as a balance between maximum sustained yield and particular land use requirements. Increased red deer population is a cause of concern as it has a substantial impact on vegetation structure and understory vegetation composition. As an intermediate feeder with a relatively large rumen, red deer tends to eat a mixed diet of about 30% grass and sedges and about 65% browse, without significant differences among seasons (Mattioli 2011). In the most productive deer habitats in Bulgaria 2.0 – 2.5 deer/km² is considered as acceptable population density. Higher densities could cause damages to forest vegetation. We tried to estimate the impact of winter red deer densities on forest vegetation and especially on understory beech saplings.

Reliable assessment of animal populations is a long-standing challenge in wildlife ecology (Caughley 1977), but the use of camera trapping to survey and monitor wildlife has increased dramatically in recent years (O'Connell, Nichols & Karanth 2011, Burton *et al.* 2015). We used camera-traps and capture-mark-recapture approach to estimate red deer population density in an area of 52.5 km² in Central Balkan mountain forests. Camera-traps were situated near four feeding places where red deer gather in winter. Additionally vantage point and line transect counts were applied. The cameras were set for 11 to 47 days in different places totaling 135 camera-trap days. The whole period was divided to 5 one-week time intervals and an encounter history of five occasions was used for analyses. Individual red deer stags were identified using their distinctive antlers' tines and by age. The survey was completed in four months, short enough to assume that we have a "closed population". Four different models were tested – equal catchability (M_0), different capture and recapture probabilities (M_b), different capture probability on each occasion (M_t), and heterogeneity in capture probabilities (M_h). The population sex ratio and age structure were also estimated from camera-traps data. Forest regeneration and deer impact on vegetation were assessed in sample plots. All saplings were counted by species, age, and height. In each sampling plot biting rate was also estimated. The analyses were performed by using programs MARK (Cooch & White 2015) and R (R Core Team 2017).

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During the survey period 360 animals were “captured” on the camera-trap pictures. We got photos of 34 individual stags, which were identified with confidence. Based on Akaike Information Criterion (AIC) the equal catchability model (M_0) was chosen as it showed the best performance. Estimated number of all males by using capture-recapture method was 34 (95% CI: 34 – 50). The male/female ratio was not significantly different from 1:1 (95% CI: 0.8 – 1.2), and fawn/doe ratio was 0.3 (95% CI: 0.2 – 0.4). Assuming equal sex ratio the population size was estimated as 80 deer (95% CI: 69 – 119), including fawns, corresponding to a density of 1.5 deer/km² (95% CI: 1.3 – 2.3). We assumed that not all animals were counted, hence the reported population size could be considered as minimal. The vantage point and line transect counts showed identical but lower population density. We consider capture-recapture method as more reliable. The red deer population density in the area is even higher according to the official statistics data. Our results about male/female ratio were not in agreement with other studies in the same area, showing disturbed sex ratio. The population age structure was biased with prevalence of younger animals and only 2 male deer above 9-years old were observed. The bite rate in all 8 sample plots was low, as only 4.07% (95% CI: 3.20 – 5.01) of saplings were damaged. Such impact on forest vegetation is considered insignificant.

Our survey showed that red deer carrying capacity in beech mountain forests could be even higher than accepted, according to game management regulations. We recommend an adaptable approach when fixing population density limits. The impact of wild ungulates on vegetation could be reliable indicator for habitat's carrying capacity. Census techniques providing more accurate and precise estimation of population density are crucial for modern wildlife management. The capture-recapture method by using camera-traps is non-invasive, cost-efficient, requires limited field effort and provides scientifically sound results. It is a powerful tool widely applied in wildlife survey methodology, but requires more explicit consideration of underlying processes, including more thorough reporting of methodological details and assumptions.

Key words: camera trap, capture-recapture, density estimation, red deer, carrying capacity

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**PRELIMINARY RESULTS FROM USING OF A NEW METHOD
FOR BULGARIA FOR DETERMINATION OF THE ACCURATE AGE
OF RED DEER (*CERVUS ELAPHUS* L.) AFTER SHOOTING**

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Abstract

In Bulgaria until now, the determination of the red deer age (*Cervus elaphus* L.) after shooting was done by the method of tooth wear, which in some cases there are deviations from the actual age. The wear is also specific for the various habitats and animal idiosyncrasy. In Bulgaria, a method of accurately determining the red deer age after shooting has never been applied, and the need to use it in the game management and game keeping field is enormous, especially in correcting and reducing the difference between the age of the animal alive, defined by hunting guides or hunters and the real one. Serious differences usually lead to the early shooting of animals with good trophy quality, resulting in losses not only financial but also from game management point of view - early removal of valuable genes or leaving unwanted ones (in case of delayed shooting). In order to check whether there is a difference between the ages determined by hunting guides and experts in the trophy evaluation protocols and those determined in a laboratory conditions by two methods – a method by teeth wear of the lower jaw (developed by Research Institute of Wildlife Ecology, Vienna, Austria) and method by growth marks in dental cementum (Mitchell 1963, 1967), the lower jaws of 89 red deer were processing. The deer were shot in 2016 (28 pcs.) and 2017 (61 pcs.) in 14 hunting grounds throughout the country (by 7 hunting grounds in the South and Northern Bulgaria). The age determined by the growth marks in dental cementum was done after longitudinal cut (3 – 4 cuts) of a first molar with low speed saw (without preliminary decalcification and subsequent polishing and coloring) and was accepted as real age because it is the most accurate one (Azorit et al., 2004). The preliminary results show that the oldest red deer was 15 years old and 75.3% of the red deer were under 10 years of age. The trophies shooting were more often on red deer with age between 5 to 9 years. After the statistical tests, a significant difference ($p = 0.015$) was found between the three type of ages and the age determinate from the trophy evaluation protocols was generally significantly higher than the real one. The age determined by the teeth wear was much closer to the real one (up to 1 year in deer less than 10 years of age) and the differences are significantly smaller. The age set by the trophy evaluation protocols was with significantly bigger differences from the real one – up to 8 years. For red deer over 10 years old, the differences between real age and the age determinate from tooth wear are greater (2 or 3 years), as the determination of a more concrete age is significantly hampered by the strong wear of the teeth. Abnormalities in tooth wear and eruption can lead to serious differences between the age determined by the teeth wear and the real one. It is necessary to improve the skills and the knowledge of the hunting guides and experts to recognize the age of the red deer, both alive and after shooting, by organizing training courses. It is recommended to create in the country regional low jaw patterns with determinate real age from growth marks in dental cementum for a more accurate age determination from teeth wear for using in practical aspect.

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**WILD BOAR POPULATION SIZES REPORTED BY HUNTERS:
ARE THEY BE INDEXES OF HUNTING SUCCESS?**

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Abstract

In a study based on the data of the National Game Management Database, we analyzed the relationships among wild boar numbers and harvest data reported by the game management units annually. From the regression analyses, strong correlations were found between the harvest of a given year and the reported population size for the next spring. This finding indicates that the previous season hunting success strongly influenced population reports in the following year. At low population densities the difference between the reported population size and the harvest declined, and above ca. 8000 boars shot/county it was somewhat stable. This pattern might indicate that in case of smaller populations the harvest numbers less closely influenced the reported population sizes (indexes) than in case of large populations.

Key words: wild boar, population harvest, population index, hunting bag, Hungary

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**ALIEN MAMMALIAN GAME SPECIES IN SLOVENIA:
STATUS, MANAGEMENT AND PERSPECTIVES**

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Abstract

Management/controlling of alien (non-native) species, particularly invasive ones, is one of the prioritized nature conservation issues since they can (in)directly affect native species and their inter-specific interactions, alter ecosystem processes, and provoke several conflicts in human-wildlife relationship. Management of (invasive) alien game species is in principle possible within the regular hunting practices/systems, therefore needed actions seem to be easily implemented. However, in reality the situation is quite opposite since general public would not support intensive management, i.e. lethal actions, and game managers are not motivated to execute such practices.

In Slovenia, seven out of 18 mammalian game species are (considered to be) non-native, i.e. they are present in the recent faunistic community due to human translocations: fallow deer (*Dama dama*), European mouflon (*Ovis aries musimon*), Alpine ibex (*Capra ibex*), coypu (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), alpine marmot (*Marmota marmota*), and raccoon dog (*Nyctereutes procyonoides*). Besides, golden jackal (*Canis aureus*) as an invading species has recently spontaneously colonized several regions. In the contribution, recent status and management of these species will be presented on the basis of data on spatiotemporal variability of annual harvest (available in the Slovene hunting information system) as well as by emphasizing common goals and directives prescribed by hunting management plans. In the respect of stating future management perspectives for each species their recent status and diverse origin will be considered: (i) raccoon dog (its presence has been documented only occasionally since 1981) and muskrat (after first appearance in 1934 the species inhabited several lakes and rivers, but the population has dramatically decreased since 1990) have dispersed in Slovenia from adjacent countries; (ii) coypu escaped from fur farms in north-eastern (in 1937), coastal and central Slovenia (in 1989), and has established several expanding populations; (iii) fallow deer, mouflon, ibex and marmot were introduced at several locations throughout Slovenia in 1950s – 1970s, primarily with the aim to increase hunting resources/revenue. Emphasis will be on presenting perspectives for coypu management as it is one of the most problematic exotic species (both considering population dynamics and its influences in human-dominated landscape) in Europe.

Keywords: *alien game species, coypu, fallow deer, mouflon, hunting-related databases*

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**EFFECT OF AGE-SPECIFIC HARVESTING ON LIMITED
STRUCTURED POPULATION**

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Abstract

The study considers effect of age-specific harvesting on a limited population that by the beginning of each reproduction season consists of two age groups: juveniles (immature individuals) and adults (mature individuals). A well-known example of pup harvest is that of the harp seal population. Another species characterized by juvenile harvest is the sable. Hunting large animals is generally a harvest of mature individuals. Among terrestrial animals, “trophy” species, such as the Saiga antelope, elephants, moose, deer, are preferred because antlers or tusks have high value.

Based on mathematical modeling method we analyze and compare dynamics of population with and without exploitation while considering age-specific harvesting. The dynamic modes of the models are investigated to identify and analyze the effects that may occur in natural populations because of various intensity harvest rates. The models proposed are examined through analytical and numerical methods, including a study on stability, bifurcation analysis, and construction of parametric portraits, dynamics modes charts, and attraction basins. Recurrence equations are applied to describe the population dynamics.

Results indicate, in the case of juvenile harvest, the way of stability loss does not depend on harvest rate and is completely determined by the intensity of competitive relationships between age classes. In the case of adult harvest, an increase in harvest rate can lead to higher stationary size of young group. As a rule, harvesting leads to the stabilization of population dynamics. However, the multistability observed in unexploited populations continues to exist. Therefore, variation in the population size can lead to a change in the dynamic modes observed. It is shown irregular harvesting or a changing harvest rate may result in fluctuations in the size of an exploited population. Therefore, constant harvest strategy may be used because changing the oscillatory mode of the dynamics is possible. In addition, controlling exploited population dynamics is sufficient to shift and retain the population number to the attraction basin of the selected dynamic mode. A one-step change in the current population size that shifts to the attraction basin of the fixed point allows the rather quick stabilization of dynamics.

The work is partially supported by Russian Foundation for Basic Research, Project 18-04-00073a and Program of fundamental research of the FEB RAS “Far East”, Project 18-5-051.

Keywords: *population dynamics, age-specific harvest, mathematical modeling, dynamics modes, multistability*

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DYNAMICS OF THE WILD BOAR'S (*SUS SCROFA* L.) STOCK AND HUNTING BAG ON THE TERRITORY OF SOUTHWESTERN STATE FOREST ENTERPRISE IN BULGARIA

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Abstract

The territory of the Southwestern State Forest Enterprise (DP Blagoevgrad) is 1 676 641,45 ha (16 766,41 km²) – the forest occupies 901 084,2 ha and the farm land cover 775 530,25 ha. According to the productivity tables and rates of the game in Bulgaria (National Regulation 18/2015), per 100 ha forest area can inhabit in spring from 0,4 to 1,5 pcs wild boars. This is rather relatively because of the changes of the habitats proper for wild boar in the direction of increasing quantitatively and qualitatively. The suitable habitats have been increased due to the reducing of the agricultural area, part of which is abandoned and gradually covered with forest vegetation. In many places there are abandoned orchards and vineyards that provide not only a good food base but also shelters. Therefore, this fact cannot be ignored, and to a certain extent this is the reason to the constant annual increase of the wild boar in the country. In 2016, according to the official spring census in Bulgaria, there were 89 184 pcs wild boar and the following year they reached 94 868 pcs. Shooting bag shows that in 2016, 36 581 wild boars were shot, or 41.0% of the spring stock, and in 2017 – 45 223 individuals or 47.7% from the spring stock. This is extremely insufficient to curb the increase in the number of wild boar in the country. The analysis for 2017 shows that the average density in Southwestern State Forest Enterprise is about 2 individuals per 100 ha forest area, which practically exceeds the permissible stock according to the productivity tables and rates, bearing in mind the fact that these results have a variation in the separate hunting grounds and the permissible stock in these territories is significantly higher than the average for the Enterprise. However, we stressed that in the habitat of the hunters' hunting grounds there is higher possibility for increasing the stock, which is shown from the census results where an increase of the spring stocks has been reached up to 20,0% from the permissible stock. In the state hunting grounds the spring stocks reach and even exceed 20%. The hunting bag in the Enterprise is an average 72.3% from the spring stock and it is highest of the areas used by the hunters – 83.2%. Nevertheless, it is clear that at this level of shooting the growth of the wild boar population in the territory of the Enterprise cannot be stopped. In view of the spreading of the African swine fever (ASF) and the increase of the hunting bag, in particular revenue from hunting tourism and game meat, we suggest to increase the shooting on the wild boar in the territories managed from the hunters and state hunting grounds managed by the Enterprise by developing hunting tourism and especially the individual hunting.

Keywords: *wild boar, population dynamics, hunting bags, game management*

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**GENETIC CHARACTERISTIC IN THE EUROPEAN BISON (*BISON BONASUS* L.)
POPULATION FROM LITHUANIA**

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Abstract

The European bison (*Bison bonasus* Linnaeus, 1758) is the largest herbivore mammal surviving in Europe. Since 1973, Lithuania has been one of few European countries with the first free ranging herd. The species is still included in the country's Red Data Book. The knowledge about population genetic diversity of this species is limited. This study aimed to estimate genetic structure in the European bison using mitochondrial DNA (mtDNA) control region. We conducted a study of genetic diversity of 30 individuals collected from a free-living Lithuania population. Variable sites, nucleotide (π) and haplotype diversity (H_d) values were estimated in the studied *B. bonasus* population in Lithuania and compared results with other studies. Current genetic diversity study indicated low mtDNA control-region sequence variation in the European bison population from Lithuania.

Keywords: *Bison bonasus*, mtDNA, genetic diversity

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**CAN THE RIVER ACT AS GENETIC BARRIER
FOR ALPINE CHAMOIS POPULATION?**

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Abstract

Alpine chamois (*R. rupicapra rupicapra*) occupy Alpine and Dinaric region between Slovenia and Croatia. In Slovenia, populations are distributed in Alps, Pohorje Mts. and in the Dinaric Mts. where they merge with Croatian chamois. In its upper course, the Kupa River flows through the Dinaric Mts. and forms a natural and political border between countries north-west Croatia and southeast Slovenia. Such natural fragmentation of habitats may have influence on genetic structure of populations by restricting gene flow among them. We used nuclear microsatellite markers to analyze the genetic population structure and movement behavior (true estimation of gene flow and isolation by distance) of chamois in fragmented area separated by natural barrier. The 56 geo-referenced individuals (39 samples from the Croatian side and 17 samples from the Slovenian side) were collected during regular hunting season. Genetic assignment of samples was performed using methods implemented in two software STRUCTURE and GENELAND. The obtained results suggested that Kupa River do not act as genetic barrier for studied chamois populations. Meanwhile, in November 2015 the refugee crisis in Europe caused construct of border security fence along the most exposed parts (178 km) of Slovenia-Croatia border. Border fence presence would determine the degree to which chamois and their genes can move among habitat patches. This would lead to limited exchange of genetic diversity between populations which may seriously affect spatial behavior of individuals and populations.

Keywords: chamois, habitat fragmentation, genetic barrier, Slovenia-Croatia border, fence

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**PHYLOGEOGRAPHY OF BROWN HARES – CLOSING THE GAP BETWEEN
 THE BALKANS AND ANATOLIA?**

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Abstract

Brown hares (*Lepus europaeus*) are widely distributed throughout Anatolia and Europe, representing one of the species whose distribution has likely been shaped by late Pleistocene climatic changes. The latest phylogeographic model suggests ancient gene flow from Anatolia to the southeastern (SE) Balkans, which has led to the supposedly single one source of all current populations on the Balkans and large parts of Europe. However, still a notable phylogenetic gap (genetic discontinuity) between hares from Anatolia and the SE Balkans does not suggest a continuous evolutionary scenario. It may be due to insufficient geographical sampling from the SE Balkans, i.e., particularly Turkish Thrace (TT). Alternatively, it may correspond to the initial phylogeographic hypothesis of a zone of secondary contact involving “Anatolian-type” and “European-type” mitochondrial (mt) lineages or still different phylogeographic scenarios. In this study we particularly increased our samples from TT and western Anatolia to better understand the cause of the phylogenetic gap in the SE Balkans. A partial fragment of the mtDNA control region was amplified and sequenced in 153 hares from TT and Anatolia. A phylogeographical analysis was carried out by a median-joining network on the currently obtained sequences and all those that were used for the latest published phylogeographical model. Among all new sequences, 92 haplotypes were revealed (102 variable sites, haplotype and nucleotide diversity of 0.989 and 0.033, respectively, calculated in DnaSp). The combined data set used for the network consisted of 609 sequences, which revealed 343 haplotypes based on 164 variable sites. Only 2 out of 92 newly obtained haplotypes were previously described. Even though the general phylogeographic model remained the same, adding samples from the geographical regions largely lacking so far reduced the phylogenetic gap by one mutational step only. Nevertheless, haplotypes of the “Balkans haplogroup” were for the first time found among Anatolian hares, which accords to our initial interpretation of a rather shallow genetic differentiation between the Anatolian hares and those from the SE Balkans. The still existing phylogenetic gap, however, indicates the necessity of more comprehensive sampling in the SE Balkans and in western Anatolia.

Keywords: *Lepus europaeus*, mtDNA, phylogeography, phylogenetic gap, Turkey

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**EUROPEAN ROE DEER (*CAPREOLUS CAPREOLUS*) – HISTORY WRITTEN
IN MITOCHONDRIAL DNA**

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Abstract

Phylogenetic studies on European roe deer *Capreolus capreolus* have so far covered southern, western and south-eastern parts of Europe. Three major mtDNA lineages (western, central and eastern) were recognized. They probably originated from three different glacial refugia located in south-western and south-eastern Europe. However, studies on phylogeography of roe deer in the northern, central and eastern parts of the continent are very scarce.

In our study, we analyzed D-loop fragment of mitochondrial DNA from over 1200 samples collected in the central-eastern part of the species ranges: from northern Scandinavia to the Balkans and from western Poland to eastern regions of the European part of Russia. In total, we found 187 haplotypes among analyzed samples. Most of mtDNA haplotypes (162) belonged to European roe deer, and they mainly clustered with the central lineage of the species. Additionally, the presence of 25 mtDNA haplotypes of Siberian roe deer *Capreolus pygargus* was discovered, among European roe deer population. They were found in Poland, Belarus, Lithuania, Estonia, Russia, Ukraine, Slovakia, Romania and Hungary. Within the studied area, the level of hybridization reached 29%. Proportions of “Siberian” haplotypes in populations were decreasing from North-East to South-West.

Our data suggest that roe deer are one of the most diverse ungulate species in the Europe. Additionally high level of hybridization with siberian roe deer was present on large area far from natural range of Siberian roe deer occurrence.

Keywords: *mtDNA, hybridization, mtDNA haplotype, European roe deer, Siberian roe deer*

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MOLECULAR IDENTIFICATION OF *BARTONELLA* SPP. IN FREE-RANGING CERVIDS AND DEER KEDS (*LIPOPTENA CERVI*) FROM NORWAY

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Abstract

In the present study, we aimed to investigate the prevalence of *Bartonella* spp. in three species of Norwegian free-ranging cervids: moose, red deer and roe deer, and deer keds and to characterise the bacteria by sequencing of the partial *gltA* gene and 16S-23S rRNA intergenic spacer region (ITS) in order to evaluate a possible transmission route. A total of 67 roe deer (*Capreolus capreolus*), 37 red deer (*Cervus elaphus*) and 156 moose (*Alces alces*) spleens were collected by hunters during culling seasons 2014 to 2016. All animals belonged to the free-living population in south of Norway. Also wingless deer ked imagines (*Lipoptena cervi*) ($n = 118$) were collected from the skin of the carcasses. For detection of *Bartonella* spp., conventional and nested PCR amplification of partial *gltA* gene and 16S-23S rRNA ITS region were used. A part of PCR products of *gltA* gene and 16S-23S rRNA ITS region were sequenced. Multiple sequence alignments were performed using Clustal W to highlight the differences between the *gltA* gene fragment and 16S-23S rRNA ITS region sequences and to perform the comparisons with related sequences found in the NCBI database. Forty-nine pools (83%) and 50 pools (85%) out of 59 of adult wingless deer keds pools using *Bartonella* *gltA* gene and 16S-23S rRNA ITS specific primers were positive respectively. Seven spleen samples (10.5%) out of 67 of roe deer, 13 samples (35.1%) out of 37 of red deer and 56 (35.9%) out of 156 moose samples were positive. Sequence analysis confirmed the presence of *Bartonella* DNA in screened samples of all studied cervid species and deer keds. The results indicate that in the Norwegian cervid populations, *Bartonella* strains from two different lineages circulated, from which one, closely related to *B. chomelii*, *B. schoenbuchensis*, and *B. capreoli* is transmitted by *L. cervi*, while for other lineage the possible vectors still remain unknown.

Keywords: *Bartonella*, roe deer, red deer, moose, Norway

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COMMON PHEASANT AS POTENTIAL RESERVOIR OF WEST NILE VIRUS

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Abstract

Common pheasant (*Phasianus colchicus*) is a non-migratory species native to Euroasia. They occupy grassland and farmland habitats. They prefer relatively open cover, such as grass and stubble fields and are found in habitats with grass, ditches, hedges, marshes, and tree stands or bushes for cover. These habitat characteristics make them closely related to mosquitoes, especially mosquitoes *Culex pipiens* species whose main breeding sites are ditches and marshes. Also these mosquitoes are ornithophilic species and the main vector of West Nile virus. WNV is a mosquito-borne flavivirus (fam: Flaviviridae) that uses birds as primary vertebrate reservoir hosts. There are very few information about pheasant infection with WNV. Basically, the most receptive birds are from order Passeriformes, but there are also data on the developed viremia in order Galliformes, where pheasants belong. In experimental infections of the pheasant family, the largest degree of viraemia was developed by Red legged partridge (*Alectoris rufa*), but what is more important is that a common pheasant was able to transmit WNV to the mosquito vector despite a manifested low viremia. Bearing in mind that viraemia in pheasants lasts on average 3.7 days, they represent potential reservoirs and transmitters of the virus. In the following period, a survey will be conducted on the topic of detection of the presence of WNV in the pheasant population.

Keywords: Common pheasant, West Nile virus, *Culex pipiens*, viraemia, reservoir

POSTER SESSION

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**MATHEMATICAL MODELING OF THE MECHANISM OF A REPRODUCTIVE
STRATEGIES DIFFERENTIATION IN NATURAL POPULATIONS
(ON AN EXAMPLE OF ARCTIC FOX, *ALOPEX LAGOPUS*)**

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Abstract

Natural populations of arctic fox inhabit coastal and inland areas considerably differ in their reproductive strategy. Coastal foxes produce litters of moderate size yearly. In years with low food supply, inland fox population demonstrates a very low rate of reproduction. By contrast, in years when prey species are abundant, female inland foxes can produce up to 16 – 18 offsprings. The average mean litter size and coefficient of variation are 1.5-fold higher in inland populations.

This paper considers a complex approach for modeling the natural evolution of a population in terms of population number and dynamics of the genetic structure. A set of dynamic models that considers various types of natural selection was applied to describe possible mechanisms underlying the formation of existing genetic variations in litter sizes in coastal, inland, and farmed arctic fox populations (*Alopex lagopus*, family Canidae, order Carnivora).

The most interesting results are obtained by using the model of population with two development stages. This model allows getting a monomorphism in considered gene for coastal populations of arctic fox, where food resources are nearly constant. Also the model produces a polymorphism with cyclic fluctuations in the number and gene frequency for the continental populations due to regular fluctuating rodent number, the major component of its food. In farmed populations this gene becomes a pleiotropic one (i.e., determining the survival rate of individuals during both early and late stages of their life cycle) due to selective selection carried out by farmers to increase the reproductive success. So an application of appropriate model (with the selection on pleiotropic gene) allows to get an adequate elimination rate of small litters allele.

Acknowledgements: This work is partially supported by the Russian Foundation for Basic Research (Project no. 18-04-00073) and the Fundamental Research Complex Program of FEB RAS "Far East".

Keywords: *evolution, population number, dynamics, genetic structure, model verification*

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**PRELIMINARY ANALYSIS OF BODY SIZE OF RED DEER (*CERVUS ELAPHUS*)
 STAGS FROM DIFFERENT HABITAT TYPES IN AUSTRIA**

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Abstract

Austrian hunting regulations categorize red deer (*Cervus elaphus*) males mainly according to three age classes: class III (1 – 4 years old), class II (5 – 9 y.o.), class I (>9 y.o.). Class I is considered the target harvest class. Discrimination between class II and I stags for shooting is done by local hunters, based on their expertise addressing body size, stature, behavior, and antler quality. Here we analyzed body size (bs) of red deer stags in three ecologically different habitat types across Austria: Alpine habitats (including Alpine basins & valleys), fringe Alpine, and non-Alpine habitats (from woodlands in flat or hilly country side, or riverine woods). Contrary to “Bergman’s rule”, we expected biggest bs in fully grown stags from non-alpine and smallest in stags from Alpine habitats, independent of geographical locations. Among class I stags we expected stable bs for all years of age, when accounting for habitat types. We based our general linear models (glm) of bs on length measurements of 297 lower jaws sent in for age determination by Mitchell’s (1967) method of counts of annual tooth cementum layers. As our data indicated a high relationship between mandible length (#2) and bs (i.e. with curved head body length $R^2 = 0.959$, $n = 21$ $p < 0,005$; with body weight $R^2 = 0.832$, $n = 25$, $p < 0,005$), even a single linear mandible measurement (#2) could be used to indicate individual bs. Our glms for stags of all ages indicated that mean bs was biggest in non-Alpine, smallest in Alpine and intermediate in “Fringe Alpine” stags. Whereas we found no age-related bs effect ($R^2 = -0.009$, $p = 0.284$, $n = 243$) for fully grown stags of class II (i.e., between six and nine years of age), bs of class I stags was negatively related ($R^2 = -0.099$, $p = 0.035$, $n = 54$) to age, when accounting for habitat type. These latter results may suggest that class I stags of relatively big bs are predominantly shot when relatively young, or that relatively small stags are rather long-lived compared to stags of big bs, possibly due to lower energy expenditure during live time (rutting season etc.). Inclusion of genetic parameters (individual heterozygosity, phylogenetic lineage, mtOXPHOS or MHC genotypes) will help disentangling ecological and genetic components of bs of Austrian red deer stags.

Keywords: red deer, body size, Austria

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**WILD BOARS (*SUS SCROFA*) MOVEMENT ANALYSIS AND USE
OF DIFFERENT HABITATS**

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Abstract

Wild boar (*Sus scrofa*) is a wide spread species. These animals are adapted to live in various habitats and population of wild boar in all Europe was growing till African swine fever emergence. In Pravirsulis botanical-zoological reserve there are very favourable conditions for wild boars. Wet thicket areas consist about 80% of all territory and around the reserve there are agricultural lands. Average density of wild boars at February there is 25 individuals/1000 ha. African swine fever was not occurred in this area till the 1st of January 2018. Objective of this research is to identify wild boars movement after the trapping and wild boars family use of various habitats. For the movement analysis and different habitat use analysis we use trapping and ear tags and/or GPS collars. A trap is a fenced area so under ideal conditions all family was trapped. Adult individuals were immobilized into the fixation cage and marked by ear tags and two of them by GPS collars. During 2016 – 2018 seasons 24 wild boars were trapped and marked by ear tags. After the release on average wild boars run 2.5 km and only after 2 hours they stop for a longer period (more than 2 hours in one place). Second year piglets marked by ear tags were hunted 2.6 – 17.0 km from the release place in one year after the release. Average one day route of wild boars family is 5.8 km. Size of home range (estimated using Minimum Convex Polygon technique) is 411.5 ha. Most of the time wild boar families spend in mixed forest during the research time. In conclusion, trapping is one of intense disturbances for wild boars in our research area but released wild boar families did not leave the home range.

Keywords: *Wild boar, trapping, GPS collar, home range*

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**ROLE OF THE RIVER TISZA AND ITS INFLUENTS AS GREEN CORRIDORS
IN GOLDEN JACKAL SPREADING IN HUNGARY**

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Abstract

The most numerous jackal population of Europe live in the Balkans, from where it noticeably started to spread north- and westwards from the beginning of the 70's, probably along valleys of River Danube and other rivers. In Hungary intensive and spontaneous re-colonisation started at the southern border-land (supposedly across River Drava from Croatia) in the 1990's. Due to the green corridors the species appeared mostly in the surrounding areas of rivers and wetlands then reached new core areas. The aim of our study was to test a hypothesis, whether River Tisza is functioning as green corridor for spreading of jackal in Eastern Hungary. We used four different methods: 1. study of the related literature; 2. collection of proof specimen and certain information (shot, photo, occasionally direct observations, etc.); 3. monitoring by acoustic method; 4. analyzing the official hunting bag data. By the results of the literature review golden jackal found its living conditions only in Nyírség and Hortobágy regions in Northeast Hungary in the last 200 years. Due to the cooperation with National parks, information about more than 40 proof specimen were collected from the Tisza region between 2006 – 2015. By acoustic survey we registered four territorial packs in the region of Tisza-Ér, Lakitelek and Csongrád, during three survey periods. Furthermore more groups were detected in the last years. Preliminary results of a built-up habitat suitability model based on a long-time acoustic monitoring also show the possible habitats close to the rivers in Eastern Hungary. Another evidence of golden jackal colonisation and spreading over the River Tisza is the appearance and growth of the official hunting bag in affected counties between 1995 – 2016. By the results of our parallel studies we suppose the source populations are likely to be in Bács-Kiskun county (between River Danube and Tisza), spreading routes in the direction of north- and eastwards are River Tisza, influents and also its valleys, flood-basins of tributary streams.

Keywords: *golden jackal, spreading, monitoring, green corridor*

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**BEHAVIOR AND ACTIVITY PATTERNS OF WOLVES (*CANIS LUPUS* L.)
IN STATE STRICT NATURE RESERVES, LITHUANIA**

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Abstract

Currently, a number of camera traps are used for security and other purposes in all territory of Lithuania. It is known that such cameras are also accidentally record wolves. Such information could be used for wolf population researches; therefore it is worth to collect such information.

Object of the research – the registration cases of wolves' and their activities' by camera traps in territories of state strict nature reserves, in Lithuania.

Aim of the research – to analyse the information about wolves' behavior and activity.

Research methods – The staff of state strict nature reserves uses camera traps for territory protection and wild animals' registration. Data from camera traps, that recorded wolves in photos and videos, were used to study behavior and activity patterns of packs and individuals. The daily activity patterns, group size and interaction between individuals were compared. The logical and statistical analyses of information from camera traps were used.

Research results. The analysis of the data provides:

Camera traps for security and animal monitoring were used in three state reserves: Viešvilė State Strict Nature Reserve, Kamanai State Strict Nature Reserve and Zuvintas Biosphere Reserve. In the territory of Čepkeliai State Strict Nature Reserve in 2017, camera traps were not used. It was estimated, the number of wolves' registrations was 40 cases in the territories of Lithuanian state nature reserves during the 2017.

The wolves were registered more often by camera traps during morning and evening hours. It hasn't been any registrations from 1 pm till 5 pm and from 12 pm till 2 am. The number of registered wolves was from one to nine individuals in one record. The average number in photo records was 1.3 individuals and the average number in video records (3 min long) was 2.6 individuals. Most often (43% of records) one individual was recorded in video.

It was verified, camera traps records opens up greater opportunities for wolf behavior research. The records reveal information about the relationship between the individuals of the wolf pack, their mood, the manner of the movement, and others.

Key words: *wolf, camera traps, behaviour, activity*

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DIVERSITY OF THE GAME FAUNA SPECIES IN THE NATIONAL PARK “MAVROVO”

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Abstract

The National Park Mavrovo is located in the northwestern part of the Republic of Macedonia, on an area locked between R. of Albania, R. of Kosovo and R. of Macedonia. The area that occupies this protected region is 72,417 ha, which represents 2.8% of the total area of the country. The altitude ranges from 600 m to 2,764 m, with a height difference of 2,164 m.

By the Law on hunting, in the Republic of Macedonia there are declared a total of 133 species of wildlife: 23 species of mammals and 110 bird species. Permanently protected are 9 mammal and 76 bird species, i.e. in total 85 species (63.9%). Hunting includes 34 wild game species or 25.6%, of which 7 are mammals and 27 bird species, while the category without protection includes only 14 species, i.e. 7 of the two classes.

The richness of the diversity of the game fauna species in the Mavrovo National Park is reflected in the fact that out of the total of 133 declared game species on the whole territory of the R. of Macedonia, 70 or 52.6% of the species (82.6% of mammals and 46.4% of birds) were registered in this park. Of these, 78.8% (58 species) are in the category “under protection”, and 12 species (21.2%) are in the category “without protection”. Of the total number of registered species, 35 (41.2%) are permanently protected.

Keywords: *National Park, diversity, game species, protection*

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**HISTOLOGICAL ANALYSES OF EUROPEAN BROWN HARE
(*LEPUS EUROPAEUS* PALL.) TESTES AND OVARIES FROM
VARIOUS REGIONS, SEASONS AND AGES FROM BULGARIA**

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Abstract

In Bulgaria, the number of the European brown hares (*Lepus europaeus*) diminishes progressively from 1970 onward, but it is more visible after 1994. Since 1995, shooting bag also diminishes significantly, especially in 2003 (there have been shot 13 334 brown hares), when it reaches its lowest number since 1933 up to present. In order to try to point the reason for the reducing stock, we analyzed the histological structure of 20 testes and 10 ovaries of hares on different ages (determined by dry eye lens weights) originate from 11 hunting grounds (2 from Northern Bulgaria, and 9 from Southern Bulgaria) taken in various seasons of the year. The samples were manipulated, according to the routine histological technology, colored with hematoxylin-eosyn and prepared as microscope durable preparations. After the performed histological analyses, we determinate, that the testes (10, 3 ± 0 , 20, diameter $\pm$ SD, mm) from young males (up to 1 year, $n = 5$) had single spermatozoa, but the active and ripe ones were missing. We observed incomplete spermatogenesis up to level spermatogoniums. On macroscopic small testes (11, 7 ± 0 , 19, diameter $\pm$ SD, mm), taken in inactive reproductive period (October – December) from adult males (above 1 year, $n = 5$), a part of the spermatozoa were ripe, but they were not active. The small channels were with suppressed spermatogenesis up to level primary spermatocytes. On macroscopic medium size of testes (17, 7 ± 0 , 04, diameter $\pm$ SD, mm), taken in inactive reproductive period from adult males ($n = 5$), almost all spermatozoa were ripe, but they also were inactive. In the most of the small channels, there were missing elongated spermatids. On macroscopic big testes (20, 6 ± 0 , 19, diameter $\pm$ SD, mm), taken in active reproductive period (January – September) from adult males ($n = 5$), all spermatozoa were ripe and active. We observed small channels with ripe elongated spermatids and small channels in a late stage of the spermatogenesis. After detailed microscope analysis, there were not recorded presence of anomalies for the spermatozoa and abnormal structural changes of the testes, which confirms that the anomalies of European brown hare spermatozoa were comparatively rare (Kozdrowski et al. 2006). For the adult males, with different testes size, we observed a difference in the structure of the testes depending on the beginning of the active reproductive period in various regions of the country, which is probably due to their geographical origin.

From the histological analyses of the ovaries we determinate, that the young females (up to 1 year, $n = 5$), still had not formed corpus luteum. At the adult females in reproductive age (above 1 year, $n = 5$), we observed tertiary follicles, which were located on a small part of the ovary and there were clearly seen the presence of degenerated corpus luteum. All investigated testes and ovaries were with normal anatomic structure, according to the season, age and region, which supposed good reproductive possibilities.

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**THE SPERM DENSITY IN TESTES OF EUROPEAN BROWN HARE
 (LEPUS EUROPAEUS PALL.) FROM BULGARIA**

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Abstract

In Bulgaria population densities of European brown hares (*Lepus europaeus*) remain at a very low level country-wide for the last 25 years, reaching a maximum of approximately 8 hares /100 ha in spring. To point the reasons for the reducing hare population, research on the reproduction were made to get overview for normal sequence of the morphological changes in the gonads during the year. Particularly we study the testicles sperm quantity (density) and testicular activity of hares from various ages (determined by dry eye lens weights, skull characteristics and Stroh (1931) method), obtained in inactive (January – September) and not active reproductive period (October – December). In order to be checked the presence of spermatozoa the tail of the epididymis has been cut on 315 hares collected for the period 2009 – 2014 from 121 hunting grounds around the country under 600 m a. s. l. On the base of slight microscope evaluation from the number (concentration) of spermatozoa and the spread were defined the quantity of sperm (Hubenov 1974) in 5 classes (1 - no spermatozoa; 2 – single (very little) spermatozoa; 3 – sparse (moderately) sperm; 4 – medium thick (high) sperm; 5 – thick (massive) sperm). The quantity of spermatozoa was biggest from the beginning of the year until the end of August, after which followed a standstill from the beginning of September to the end of October. The testes activity was activated in November. Individuals up to 6 months of age had no or single spermatozoa (1st and 2nd class of sperm), independently that they were shot in June, July and August. In the age between 7-9 months, already there were individuals with (class of sperm 4th), which were born in the summer of the previous year and follow the rhythm of the beginning of the active reproductive period from the end of the autumn, as it is in the adult hares (above 1 year old). The hares, born later in the reproduction season, i.e. after July from the previous year, resemble to those, which were born in the beginning of the current year (January – March), and show a strong growth of the reproductive tract at the age of 3 months. All hares, in age between 10 – 12 months, had already reached the puberty and sexual maturity, and can participate in the reproduction (they had class of sperm from 3rd to 5th), independently that they were born in the middle or in the end of the previous year. The adult individuals had class of sperm 3rd, 4th and 5th, during the whole reproductive period. Individuals born between February and June, which had reached the end of development of their body in the autumn, when the inactive reproduction period proceed, their puberty were postponed for several months, until the beginning of the next reproduction period. The young hares reach the puberty only in the reproductive period and reach sexual maturity at 2 – 3 months of age. The age at which the puberty is reached is depending on the date of birth. Individuals with age up to six months, shot inactive reproductive period, already had class of sperm 3rd. Hares with age above 7 months were represented by all classes of sperm, although for some of them, the reproductive period has not begun, and the testes were in standstill. During the whole year with class of sperm 4th and 5th the young hares (up to 1 year) were only 16% and adult hares – 32%. Young individuals, who had no spermatozoa or single ones were 51%, while adult hares were 22%. The average quantity of the spermatozoa was bigger for adults (46%), than for young individuals (33%). The results confirm the proofs about the existence of a normal reproductive cycle in Bulgarian hares with stages of activity and standstill.

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ASSESSMENT OF THE POPULATION GENETIC DIVERSITY OF RED DEER IN BULGARIA: INFERENCES FOR POPULATION SUSTAINABLE MANAGEMENT

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Abstract

The European red deer (*Cervus elaphus* L.) is the most important big game species in Bulgaria with marked habitat fragmentation. The species is known to be strongly anthropogenically influenced by recent human activities in the country such as selective hunting for trophies. To estimate the haplotype diversity of red deer from Bulgaria, a complete sequence of cytochrome b (1140 bp) was analyzed in individuals inhabiting red deer from two subpopulations of its mega-population in the Shumen district in NE Bulgaria, one from Balkan Mountains, on the northern slopes of the Central Balkan range and one from Middle Rhodope Mountains. Thirty-six haplotypes were revealed in the investigated populations; thus much, at least, is clear the existence at least two different genetic lines of red deer in Bulgaria. The carried out a comprehensive description of the genetic structure of Bulgarian red deer populations and comparative analysis of their phylogenetic relationships among some other subspecies of *Cervus elaphus* in Europe does not exhibit remarkable loss of genetic diversity of the red deer in Bulgaria. These results are discussed in respect to population conservation, sustainable management and prevention of loss of genetic diversity of red deer in Bulgaria as well as to assess the effects of human activities indicating the human impact on population structure most likely resulting from selective hunting for trophies. Therefore, additional information on red deer population history, biology, ecology and recent genetic status must be collected in more regions in Bulgaria to clarify in details the conservation genetics of red deer, as one of the urgent measures to protect its population biodiversity in the country.

Keywords: *Cervus elaphus*, Bulgaria, red deer, genetic diversity

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**M3 HIGHWAY AS A POTENTIAL BARRIER OF WILD BOAR
 (SUS SCROFA) POPULATIONS IN HUNGARY**

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Abstract

Wild boar (*Sus scrofa*) is a widespread prevailing species in Hungary, with a long-term increasing number of individuals. Earlier studies showed that the Hungarian population is homogenous however study based on other genetic markers and larger sample size can give more accurate results. Studies from different countries revealed that the roads, especially high-traffic highways with walls or fences acts as a minor/medium effect barrier with medium and big game species.

To establish the genetic profiles of the 70 wild boar samples (blood, meat, hair or skin) from both part of the M3 highway were collected and used for genomic DNA isolation. For genotyping 13 tetrameric STR markers (PigSTR1A, PigSTR1B, PigSTR4B, PigSTR4C, PigSTR5C, PigSTR7B, PigSTR11A, PigSTR11B, PigSTR13E, PigSTR14A, PigSTR14B, PigSTR15A, PigSTR17A) described in pigs, and 6 previously developed InDel markers (373D1, 379M2, 381W1, 382W2, 383W3, 384W4) redesigned by the needs of the present research were used. Samples were assigned to two groups based on their localities: northern ($n = 40$) and southern ($n = 44$) parts of the highway. After laboratory analysis the main genetic diversity indices, genetic differentiation within populations, genetic differentiation and structure among populations, gene flow between populations with Arlequin, FSTAT, Structure and PCA programs will be studied.

Preliminary results from 40 samples with STRUCTURE software suggested that wild boar populations from north ($n = 20$) and south ($n = 20$) part of the M3 highway are not differentiated. Thus there is no isolation in the wild boars by the highway barrier what was built 40 ys ago. Expanding this study to include additional sites between the locations would allow us to have more precise result about genetic diversity and structure of wild boar populations and it might help in the management and gene conservation of wild boars in the studied territories.

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Keywords: *Sus scrofa*, wild boar, barrier, highway, Hungary, STR, InDel

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**WILD BOARS IN SERBIA: GENETIC DIVERSITY AND POPULATION
STRUCTURE AS INFERRED BY MICROSATELLITES**

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Abstract

The wild boar (*Sus scrofa*) is one of the most abundant wild ungulates in Europe, as well as in Serbia. It is an important wildlife species, both economic and ecologically. During the nineteenth and early twentieth centuries wild boars faced the strong demographic declines and regional extinctions and have shown a remarkable increase in population density in the last four decades. Due to the named factors, accompanied by the developments of molecular genetic tools for wildlife management and conservation, wild boar populations have become in a scope of interest in population genetic studies. In order to assess genetic diversity and population structure, sample of 98 wild boars from Serbia were genotyped by eleven microsatellite loci. Genetic variability parameters were calculated in Genetix and GenAlEx, while the presence of spatial genetic patterns was assessed by spatial Principal Component Analysis (sPCA) in adegenet. The shape plot of patterns of genetic diversity across the landscape and isolation by distance were tested by Alleles in Space. A total of 134 alleles were detected, with an average value of 12.18 alleles per locus. The observed heterozygosity ($H_o = 0.697$) was lower than expected heterozygosity ($H_e = 0.788$), with an overall FIS value of 0.117. Four loci out of eleven exhibited significant deviation from the Hardy-Weinberg equilibrium. Multivariate sPCA analysis indicated significant single global structure and no local structures, separating wild boars from Vojvodina from those from the central and southern Serbia. The observed spatial pattern was further supported by the landscape shape interpolation plot of genetic distances between individuals. High genetic diversity is present in wild boars in Serbia, indicating high genetic potential of the species.

Keywords: *game management, genetic variability, microsatellites, population structure, Sus scrofa*

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**MICROSATELLITE BASED GENETIC DIVERSITY OF BROWN HARES
(*LEPUS EUROPAEUS*) FROM HUNTING GROUNDS
IN VOJVODINA PROVINCE (SERBIA)**

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Abstract

Brown hares (*Lepus europaeus*) represent an important game species, which faced remarkable decline throughout its range in the last few decades. Since genetic variability underpins the ability of populations for a long term survival, characterization of genetic diversity is a crucial step for development of proper sustainable and management practices. In order to assess genetic variability of brown hares from Vojvodina Province (Serbia), a total of 59 muscle tissue samples collected across the seven hunting grounds were genotyped at five microsatellite loci. Genetic variability parameters were calculated in Genetix, Arlequin and GenALEX. A mean of 10 alleles per locus was found, with a range from 6 to 18, while the number of effective alleles per all loci in each hunting ground ranged from 3.6 to 6.4. Private alleles were detected in four hunting grounds. Overall expected heterozygosity (0.653) was higher than the observed heterozygosity (0.502), while mean observed heterozygosity across loci within each hunting ground ranged from 0.411 to 0.571. Number of loci deviating from Hardy-Weinberg equilibrium ranged from 1 to 3. The estimated average FIS value for each hunting ground ranged from 0.178 to 0.467. Genetic differentiation was moderate with a mean FST of 0.069, while average FST values ranged from 0.051 to 0.201. Percentage of variation within hunting grounds was 93.02%, and 6.98% among hunting grounds. The results of this study indicate moderate genetic diversity and deficit of heterozygote, which may be attributed to an inbreeding effect.

Keywords: microsatellites, hunting grounds, genetic diversity, brown hares, Vojvodina

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NO SIGNAL OF MOLECULAR ADAPTATION IN THE *NADH DEHYDROGENASE SUBUNIT 6* GENE IN BROWN HARES (*LEPUS EUROPAEUS*) FROM EUROPE AND ASIA MINOR

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Abstract

Genetic variation in mitochondrial (mt) protein-coding genes involved in oxidative phosphorylation (OXPHOS) may affect cellular energy production and cause regional adaptation due to different environmental (climatic) pressure. Brown hares are widespread throughout Europe and Asia Minor and occur in a variety of heterogeneous landscapes. Based on earlier findings in mt OXPHOS genes of diverse hare species, we hypothesized that brown hares showed adaptive variation in their mtDNA in response to habitat and environmental heterogeneity. Specifically, we sequenced the *NADH dehydrogenase subunit 6* (MT-ND6) gene of 251 hares from Europe and Asia Minor. Molecular diversity indices were calculated in DnaSP, while spatial clustering was assessed using Geneland in R. The presence of selection signals was tested by codeml in PAML. Moreover, generalized multinomial models were run in R to test for effects of environmental variables on the occurrence of the most prevalent MT-ND6-protein variants. Fiftyone haplotypes were revealed with a diversity of 0.797, coding for 16 different protein variants. Spatial clustering indicated four geographical groups: Asia Minor, the Balkans, Central Europe, Western Europe. Haplotype and nucleotide diversity values decreased gradually from Anatolia to the Balkans, central, and western Europe. Three codons (pos. 4, 102, 126) were proved to be under positive selection. Nevertheless, the modeling results revealed only an effect by geographical longitude on the occurrence of protein variants. Thus, despite the positive selection signal for the MT-ND6 locus, the spatial distribution of protein variants encoded at this locus may predominantly reflect neutral population genetic patterns that have been established in the course of the recent colonization history of the hares during late glacial or postglacial times. Alternatively, currently unexplored environmental or coevolutionary factors might shape the geographical distribution of the MT-ND6 protein variants.

Keywords: adaptation, oxidative phosphorylation, positive selection, mitochondrial DNA, brown hares

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**ANALYSIS OF GENETIC VARIABILITY AND POPULATION STRUCTURE IN
WILD POPULATION OF RACCOON DOG (*NYCTEREUTES PROCYONOIDES*)**

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Abstract

The aim of this study was to evaluate the phylogeographic structure of raccoon dogs based on sequence polymorphisms of the mtDNA control region and to investigate the impact of anthropogenic pressure on the formation of population structure and the genetic diversity of raccoon dogs using microsatellite markers. A total of 153 *N. procyonoides* individuals legally harvested by the hunters and found killed on the roads from 37 sampling sites across Lithuania were investigated. We analyzed 22 sequences of the D-loop region of the mitochondrial DNA (mtDNA) and 15 microsatellite loci for genetic characterization of the studied populations. The phylogenetic analysis of mtDNA in raccoon dogs demonstrated the presence of two haplogroups. The patterns of molecular genetic variation in raccoon dogs from Lithuania obtained in the present study indicated higher genetic diversity of these animals as compared with those from West Europe, but lower genetic polymorphism as compared with raccoon dogs introduced to the European part of Russia. The analysis of microsatellite loci showed a high level of genetic variation observed within subpopulations, but low level of variation portioned among subpopulations. The significant correlation between genetic and geographic distances indicated isolation that reflected the distance between locations. The fencing of highways and very intensive traffic could be barriers to gene flow between the western and eastern sampling areas of raccoon dogs.

Keywords: *Nyctereutes procyonoides*, genetic diversity, mitochondrial DNA, microsatellite loci

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**DO INDIVIDUAL HETEROZYGOSITY AND PHYLOGENETIC LINEAGES
AFFECT FEMALE REPRODUCTION IN BULGARIAN HARES?**

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Abstract

The “overdominance hypothesis” predicts a positive effect of highly heterozygous organisms on their fitness. However, the many studies on this issue have so far not produced consistent results, possibly due to the different fitness parameters used, among other aspects. Here, we test whether fertility of females of brown hares (*Lepus europaeus*) from Bulgaria was affected by their individual heterozygosity. We expected a positive relationship between individual heterozygosity as estimated by eleven microsatellite loci and fertility as indicated by placental scars after the end of the reproductive season in 54 adult hares collected in southeastern, south-central, and northern Bulgaria between 2010 and 2013. Age classification was carried out by dry eye lens weights, which allows, however, only a very rough classification in fully grown individuals. In our statistical modeling of the individual placental scar numbers we also included body size of the hares as indicated by condylobasal length (cbl) and data on infection with *Taenia pisiformis* (cysticercosis). Moreover, as Bulgarian hares harbor in their mitochondrial (mt) DNA two somewhat different phylogenetic lineages, namely ancestral “Anatolian/Middle Eastern” on the one hand and more modern “European” lineages on the other, we included this information in our models as well, as mtDNA OXPHOS genes play a key role in the cellular energy production and may thus affect reproduction. Specifically, we classified our *MT-ATP6* sequences as either “Anatolian/Middle Eastern” or “European” haplotypes. Our preliminary mixed effects models suggested only a significant ($p < 0.05$) effect by the *MT-ATP6* haplotype, when accounting for all other variables, with females harboring “Anatolian/Middle Eastern” haplotypes featuring on average 11.2 offspring per female and year and those with “European” haplotypes only 9.8. Thus, the overdominance hypothesis was not supported by the present data set. The significant *MT-ATP6* haplotype effect may indicate a somewhat more efficient energy production in females harboring an Anatolian/Middle Eastern haplotype allowing for higher reproductive output. To confirm our present result, clearly more samples would be needed. Ideally experimental trials involving sequences of all thirteen mt OXPHOS genes should help to understand the meaning of the phylogenetically different mt lineages for the reproductive performance in hares from the Balkans.

Key words: *MT-ATP6* sequences, haplotype, placental scars, brown hare

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**ESTIMATION POPULATION DENSITY OF EUROPEAN BROWN HARE
POPULATIONS BY SPOTLIGHT IN TWO DIFFERENT HUNTING AREAS
IN HUNGARY**

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Abstract

The European brown hare (*Lepus europaeus* Pallas, 1778.) is one of the most important small game in Hungary. Its populations indicate declining trend for several decades. Knowledge of the population parameters, from the perspective of game management are very important factors. Population density affects the number of hares that can be utilized by hunting. Between 2014 and 2017 every late autumn and early spring population density were estimated at night by spotlight counting method Kovács (1986) in two hunting areas in Békés and in Jász-Nagykun Szolnok county. The first area is little hunting area (ca 4 700 hectares) with many disturbing factors (close to big city, main roads, railways and farmsteads). The second one is large (ca 20 000 hectares) area with less distracting factors. Estimate were made of 10% of hunting fields by jeep, where there is little plant cover could be found. Our survey was conducted on precipitation free days, three consecutive days per areas. Population density were found in autumn between 0,15 – 0,16 hares/hectares (1st area) and between 0,12 – 0,18 (2nd area). Population density at the end of February were 0,09 – 0,16 (1st area) and 0,12 – 0,13 hares/hectares (2nd area). Our results have been evaluated using a two-sample *t*-test. After examining and comparing irregular and normal values, there was no significant difference neither in the population density in autumn (Sig. 2-tailed 1,00, SE: 0, 02, *p* = 0, 04) nor in early spring density (Sig. 2-tailed 0,69, SE: 0, 02, *p* = 0, 03) between the two hunting areas. Based on our studies, the density of brown hares in both areas were acceptable regardless of the type of habitat.

Keywords: Brown hare, estimation population density, spotlight

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**ESTIMATION OF THE POST MORTEM INTERVAL BASED
ON THE BIOCHEMICAL PARAMETERS OF VITREOUS FLUID OF RED DEER:
POSSIBLE APPLICATION IN POACHING INVESTIGATIONS**

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Abstract

The ability to estimate the post mortem interval (PMI) in wild species is a skill greatly desired by law enforcement personnel or by crime scene investigator. This could be of crucial importance as evidence in poaching investigations to determine whether the animals were hunted during the closed season or to match the presence of a suspect at an illegal take scene (area where they do not have permission for hunting). Understanding of the physical and chemical changes that occur in the body post mortem is critical for accurate interpretation of gross and microscopic pathological lesions. Furthermore, the understanding of many unpredictable changes governed by postmortal processes and the factors that affect them will ensure more accurate estimation of PMI. Biochemical analysis of different body fluids in relation to death interval has become a useful supplementary procedure to other traditionally used signs. The vitreous fluid is one of the body fluids that could be of substantial importance in assessment of PMI. Herein, the preliminary study of the correlation between increasing PMI and levels of the different biochemical parameters in vitreous fluid (sodium, calcium, magnesium, chloride, potassium, phosphorous, AST, urea, creatinine, total protein, glucose and total cholesterol) is presented. The eyes from six red deer carcasses were enucleated and covered by a parafilm and aluminium foil, packed in a small container and maintained at +4°C. Sampling of vitreous fluid was done at 8, 10 and 12 h post mortem and then regularly each 10 hours till final 90 hours. Linear regression analysis was applied to model the correlation between analysed biochemical parameters and time since death. The significant linear correlation was found for potassium and sodium level in vitreous fluid ($p < 0.0001$). This preliminary data showed that the changes in the level of potassium and sodium in the vitreous fluid could be used to determine the PMI in red deer.

Keywords: *PMI, vitreous fluid, red deer, poaching*

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**THE IMPACT OF THE TYPE OF HUNTING GROUND
ON HARE AGE STRUCTURE (*LEPUS EUROPAEUS*)**

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Abstract

The objective of this research was to study the impact of the type of hunting ground on the age structure of hares shot. The analysis included 256 hares shot. In hunting grounds in lowland region of Serbia (Vojvodina) 129 hares were shot while in hunting grounds in Central Serbia which belong to a mountainous type of hunting grounds 127 hares were shot. The hypothesis about a proportion of two main independent sets by means of chi-squared test within the SAS PROC FREQ procedure was tested. In both types of hunting grounds a dominant share in population constitute hares aged from 6 to 12 months (Vojvodina 42%, Central Serbia 37%). In addition, a low share of hares younger than 3 months was determined, being below 1% in both cases. The greatest difference in age structure was determined in hares older than 3 years. In Vojvodina this share accounted for 12.5% while in Central Serbia the share of this group accounted for 28%. Chi-squared test showed high statistical significance ($p < 0.01$), what supports the thesis that type of hunting ground can have a high statistical impact on the age structure of hares in hunting grounds.

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Keywords: hare, type of hunting ground, age structure, χ^2 -test

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**POSSIBILITY OF USING CRANIOMETRIC DIMENSIONS
TO ESTIMATE THE AGE OF HARE (*LEPUS EUROPAEUS*)**

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Abstract

The objective of our research was to estimate the years of age of European Brown hare which was done on the basis of measuring some skull dimensions in order to make the procedure both simpler and faster and to maintain the estimation accuracy at the same time, instead of measuring based on hare dry eye lenses which up to now, has been commonly accepted procedure. The experimental material used in the research was collected in 5 hunting grounds in Central Serbia and included 127 hares shot during the 2017/2018 hunting year. Hare age was estimated by the method of measuring hare dry eye lenses. The measurements of dimensions of the width of lower and upper incisors and width of forehead were performed on hare skull. On the basis of hare age estimated by the mass of eye lenses we have constructed a multiple regression equation where the relationships between the width of lower and upper incisors and the width of forehead and the age of individuals shot were estimated. The equation was statistically highly significant and derived in a following form $y = 49.64 \cdot \text{ŠGS} + 37.25 \cdot \text{ŠDS} + 2.86 \cdot \text{ŠČ} - 375.14$ (ŠGS-width of upper incisors, ŠDS-width of lower incisors, ŠČ- width of forehead). By measuring the width of lower and upper incisors and the width of forehead the hare age can be successfully estimated, even in live animals, what is deemed significant both in practice and when assessing the damage made by hares

Keywords: *craniometry, European hare, age structure*

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**SEX RATIO OF RED DEER (*CERVUS ELAPHUS* L.)
IN THE CENTRAL BALKAN MOUNTAINS AND NORTH-EASTERN BULGARIA**

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Abstract

The aim of this study is to establish the current sex ratio in the population of red deer from the Central Balkan Mountains and North-eastern Bulgaria, where the main part of the stock of the species is concentrated in the country. Data on direct observations of 3948 red deer individuals of both sexes collected in the period 2011 – 2018 in the regions of Cherni Osam, Apriltsi, Central Balkan National Park, State Hunting Enterprise “Rositsa” – Lagat, State Hunting Enterprise “Mazalat” and State Hunting Enterprise “Voden – Iri Hisar” was used. The established sex ratio in the Central Balkan Mountains is in the range males: females = 1 : 6,9, and in North-eastern Bulgaria – males : females = 1 : 2,6, in favour of females.

For the territory of State Hunting Enterprise “Rositsa”-Lagat in 2017 the data are compared with similar data obtained from the traditional spring counts for the game species for the same period (males : females = 1 : 1,6), as well as data from a camera trap study in July-August 2017 (males : females = 1 : 6,4) .

The obtained results reveal a serious problem in the management of red deer in Bulgaria. The analysis of the causes of the current situation needs to become a sound scientific basis for identifying and taking measures to normalize the sex ratio of the population in our country.

CONCLUSIONS:

- In the Central Balkan Mountains, the sex ratio of the red deer is severely disturbed in favour of the females.
- In North-eastern Bulgaria the prevalence of females does not meet the goal of red deer management there.
- Data from the spring counts of game species differ significantly from those obtained during the survey.

Keywords: *Red Deer, sex ratio, habitats, hunting enterprise*

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