Workshop on *In situ* and *Ex situ* gene conservation
12-13-14 April 2016
Gödöllő, Hungary

In situ and Ex situ gene conservation in Russia

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All-Russian Research Institute of Animal Husbandry
named after Academy Member L.K. Ernst

(L.K. Ernst Institute of Animal Husbandry)

Moscow region, Dubrovitsy

Data 2015

The ratio of Russian and foreign breeds by the main species
(identified in the State Register)

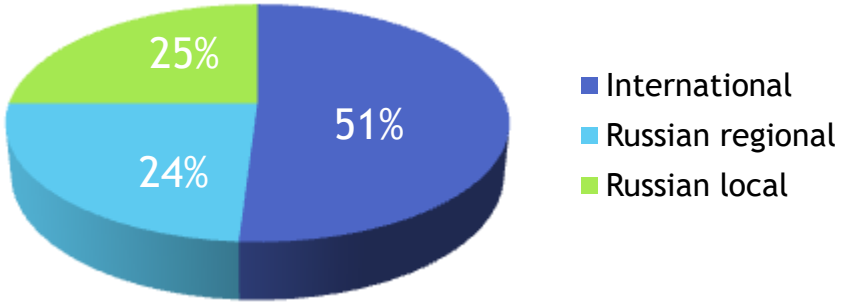
Species	Number of breeds	Including of Russian origin	In situ conservations *
Cattle	39	18	11-8
Pigs	18	9	2-2
Sheep	44	28	19-8
Goats	8	5	1-1
Horses	44	29	12-7
Chickens	52	12	6-38
Geese	27	14	10-9
Turkey	7	5	6-6
Ducks	3	1	6-2
Rabbits	12	5	3-3
…	…	…	…
Total	416	197	57-96

*) number of “gene fund” farms – number of breeds

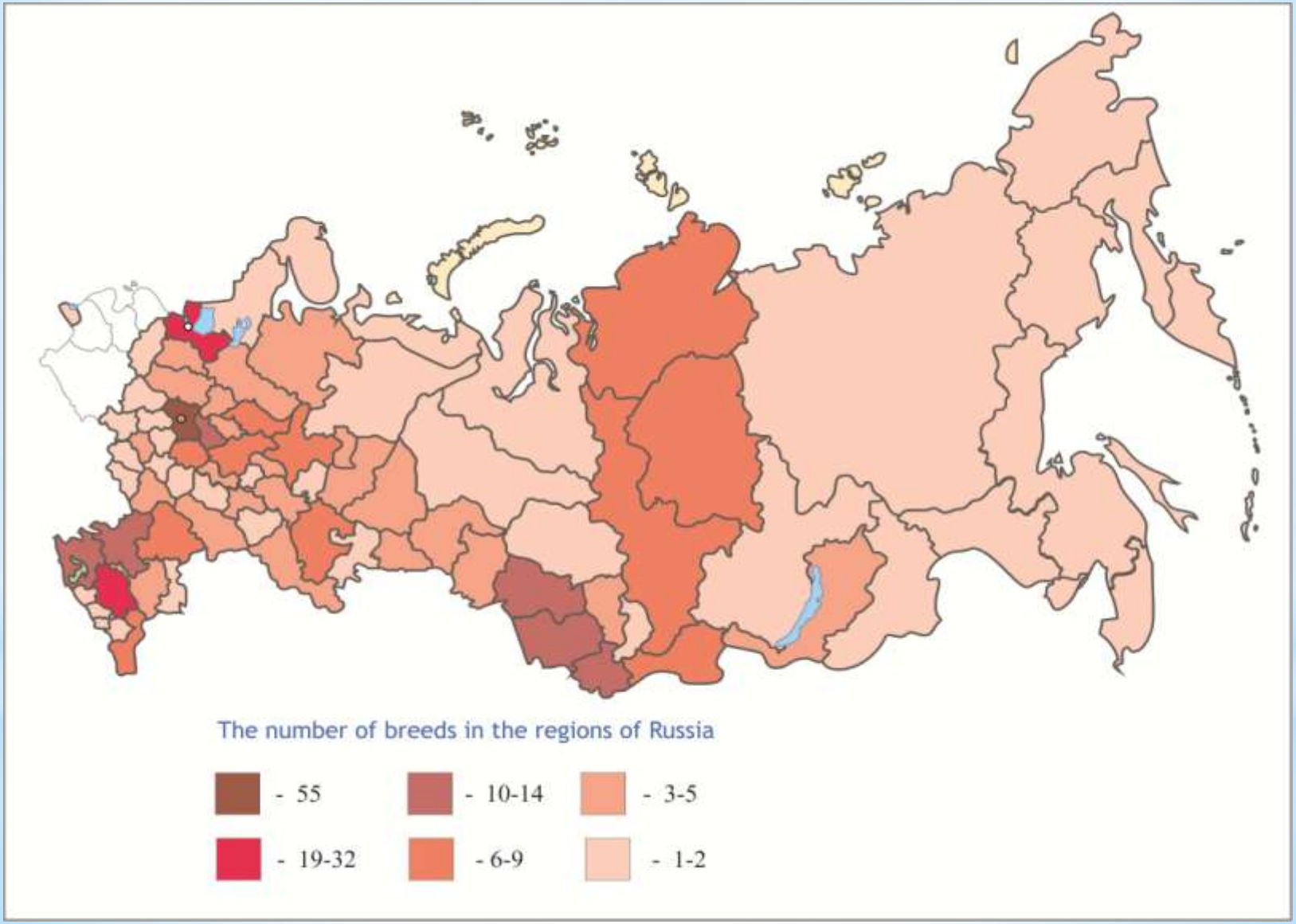
More than 400 breeds belonging to 47 species of domesticated animals are currently bred in the Russian Federation: mammals (21 species), poultry (9), fish (15) and insects (2).

The greatest number of breeds in the species belongs to dogs (56 breeds), chicken (52), horses (44), sheep (43), cattle (39), geese (27), pigs (17).

The ratio of Russian and International breeds identified in the State Register



Distribution of Russian origin breeds by regions of Russia (for 33 Domestic species)



Structural organization of livestock breeding in the Russian Federation
(by type of organization and animal species)

		Dairy Cattle	Beef Cattle	Sheep	Goats	Pigs	Horses	Rabbits	Chickens	Ducks	Geese	Quails	Turkeys
1.	Breeding center (association) per breed	19	4	2	1	2	3	1	2	-	-	-	-
2.	Artificial insemination organization	52	18	3	1	1	2	-	2	-	-	-	-
3.	Embryo transplantation organization	3	-	-	-	-	-	-	-	-	-	-	-
4.	Organization for recording, control, performance, quality and pedigree value assessment *	63	13	5	2	7	29	1	3	2	2	1	1
5.	Breeding center for storage and use of pedigree semen	39	12	-	-	-	-	-	-	-	-	-	-
6.	Regional information and breeding center	36	7	3	1	15	17	3	1	1	2	-	-
7.	Breeding farm	473	53	63	1	55	52	39	9	-	4	-	2
8.	Breeding multipliers	866	225	139	10	83	126	68	73	4	3	-	3
9.	Genetic resource farm	14	-	19	2	2	10	7	6	5	10	1	6
10.	Selection hybrid center	-	-	-	-	4	-	-	-	-	-	-	-
11.	Breeding and genetics center	-	-	1	-	5	-	-	2	2	-	-	1
12.	Horse breeding farm	-	-	-	-	-	10	-	-	-	-	-	-

Data provided by S. Kharitonov, 2015

Number of breeds for which the following activities are undertaken

Tools	Cattle (dairy)	Cattle (beef)	Sheep	Goats	Pigs	Horses	Rabbits	Chickens	Ducks	Geese	Quails	Turkeys
Animal identification	20	11	29	4	10	33	5	37	3	12	2	7
Breeding goal defined	20	11	29	4	10	33	5	37	3	12	2	7
Performance recording	20	11	29	4	10	33	5	37	3	12	2	7
Pedigree recording	20	11	29	4	10	33	5	37	3*	12*	2*	7
Genetic evaluation (classic approach)	20	11	29	4	10	33	5	37	3	12	2	7
Genetic evaluation including genomic information	1	-	-	-	-	-	-	-	-	-	-	-
Management of genetic variation (by maximizing effective population size or minimizing rate of inbreeding)	20	11	29	4	10	33	5	37	3	12	2	7
Artificial insemination	20	11	Certain breeds in some farms (non systematically)									

Data provided by S. Kharitonov, 2015

Challenge for Russia*	**Loss of biodiversity**
Threat for Russia*	**Low efficiency of agricultural production**
Solution	**Development of modern methods of management of Farm Animal Genetic Resources**

Examples of biodiversity conservation projects *in vivo*:

«Comprehensive analysis of gene pools of domestic species and of domesticated animal populations, using morphological, genetic and molecular genetic methods»

Vavilov Institute of General Genetics, Moscow

«Preserving gene pool of poultry breeds»

All-Russian Research and Technology Institute of Poultry (VNITIP), *Moscow region*

All-Russian State Research Institute of Genetics and Breeding of Farm Animals (VNIIGRZH), *St. Petersburg region - Pushkin*

Vladimir Agricultural Research Institute (VladNIISH), *Vladimir*

North-Caucasian Zonal Experimental Station of Poultry (SKZOSP), *Stavropol region*

Selection and genetic center for waterfowl breeding "Poultry Breeding Plant" Blagovarsky", *Bashkortostan*

** Long-range forecast of scientific and technological development of the Russian Federation until 2030 (2013)*

Preserving gene pool of poultry breeds

VNITIP: 74 CHICKEN BREEDS, 6 GUINEA FOWL BREEDS, 6 QUAIL BREEDS

VNIIGRZH: 29 BREEDS AND 10 POPULATIONS OF CHICKEN

VLADNIISH: 21 GEESE BREEDS

SKZOSP: 6 TURKEY BREEDS

PBP «BLAGOVARSKY»: 8 DUCK LINES, 8 GEESE BREEDS, 3 GUINEA FOWL BREEDS

Russian Science Foundation (RSF): project № 14-36-00039

«Investigation, conservation and sustainable using of animal biodiversity as the basis to produce healthy, safe and high-quality food»

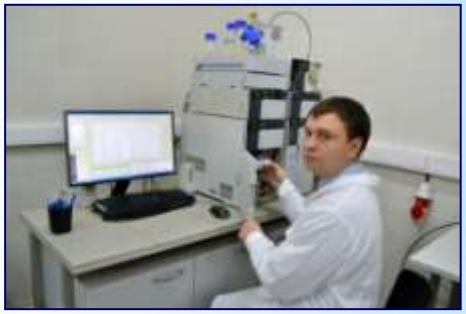
Aim of the project: characteristics of biodiversity in total and genetic resources of agricultural animals in particular as the basis for production of healthy, safe and high-quality food to improve the human habitat.

Institutions participating in the project

Head of the project - Dr. biol. Sci., member of the Russian Academy of Sciences Natalia A. Zinovieva






PROJECTS' TASKS

Creation of DNA banks of agricultural animals and related wild animal species

Evaluation of biodiversity of animal species and breeds at the gene and genome levels (microsatellites, mtDNA, whole-genome SNP screening)

Creation of cryobanks of genetic materials as a form of conservation of genetic resources

Development of new breeding forms using the gene pool of culture breeds and wild animal biodiversity

Study of relationships between genetic diversity and nutritional biodiversity of food

DNA BANKS OF DOMESTIC AND RELATED WILD ANIMAL SPECIES

DOMESTIC SPECIES

- ✓ Cattle: 10 breeds
- ✓ Yaks: 3 ecotypes
- ✓ Sheep: 12 breeds
- ✓ Goats: 3 breeds
- ✓ Rein deer: 3 breeds
- ✓ Honey bee: 10 ecotypes

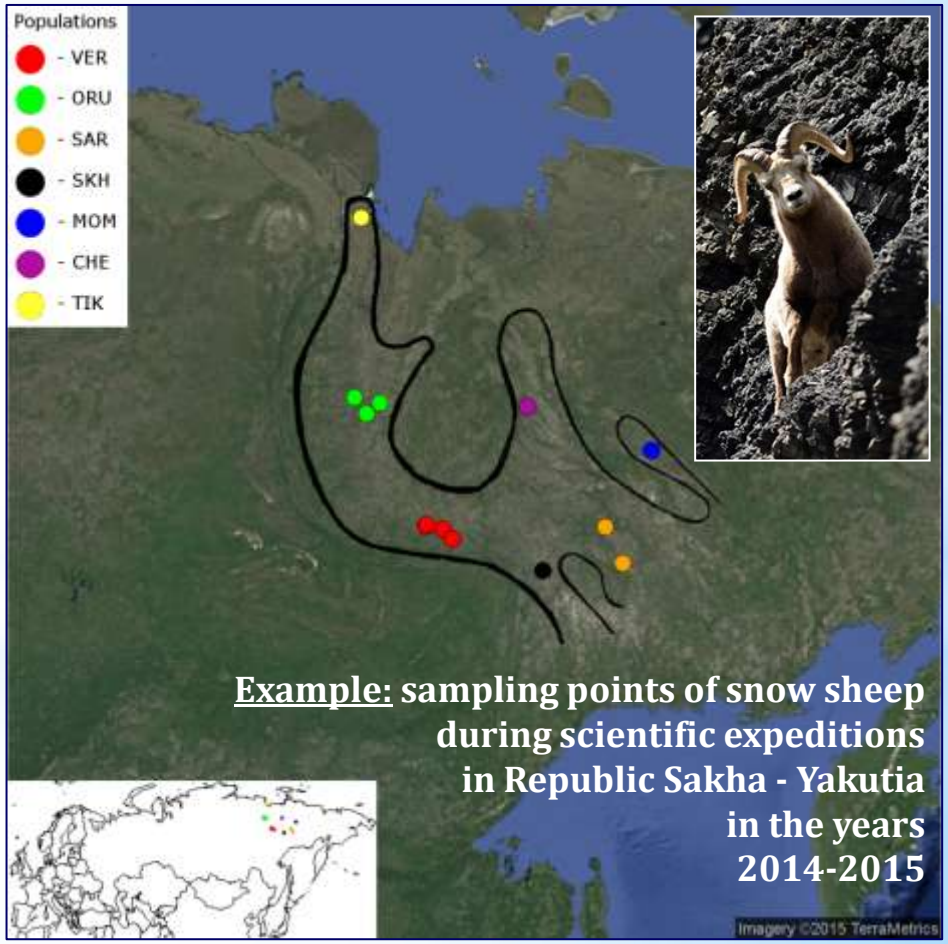
HYBRIDS

- ✓ Romanov sheep * Snow sheep
- ✓ Romanov sheep * Mouflon
- ✓ Romanov sheep * Argali

Example: F2 hybrids of Romanov sheep and Argali

WILD SPECIES

- ✓ Argali (2 samples)
- ✓ Snow sheep (>50 samples)
- ✓ Rein deer (>50 samples)



Example: sampling points of snow sheep during scientific expeditions in Republic Sakha - Yakutia in the years 2014-2015

THREE TYPES OF HIGH-INFORMATIVE DNA MARKERS HAVE BEEN USED TO STUDY THE ALLELE POOL OF ANIMAL SPECIES:

- ✓ **Microsatellites (STR) – high-informative selection-neutral genome sequences (probability of identity - $<10^{-10}$)**
- ✓ **Mitochondrial DNA (maternal heritability)**
- ✓ **Whole-genome scanning of single nucleotide polymorphisms (SNP) using medium density DNA BeadChips (simultaneous analysis more than 50 thousands SNPs)**

RESEARCH RESULTS (1)

It was shown that Russian local cattle breeds (Yaroslavskaya, Kholmogorskaya, Yakutskaya) carry the unique alleles, which are absent in culture cattle breeds

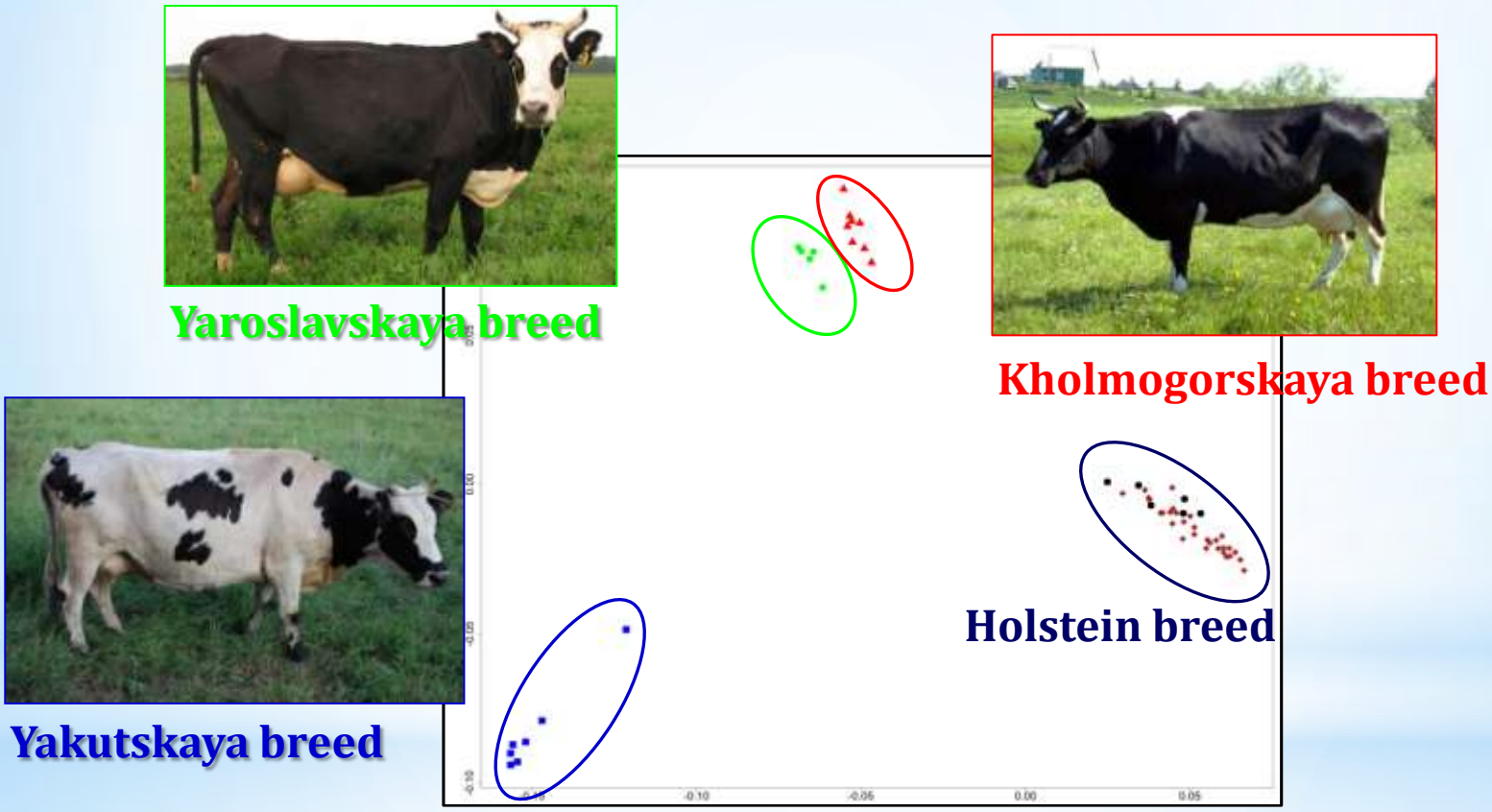


Fig. 1. – Differentiation of local Russian cattle breeds based on the whole-genome SNA analysis

RESEARCH RESULTS (2)

Genomic profiles of six Russian sheep breeds were obtained. It was shown that all studied breeds carry the alleles, which are absent in other breeds. The most genetically distinct breed of sheep is Romanov.

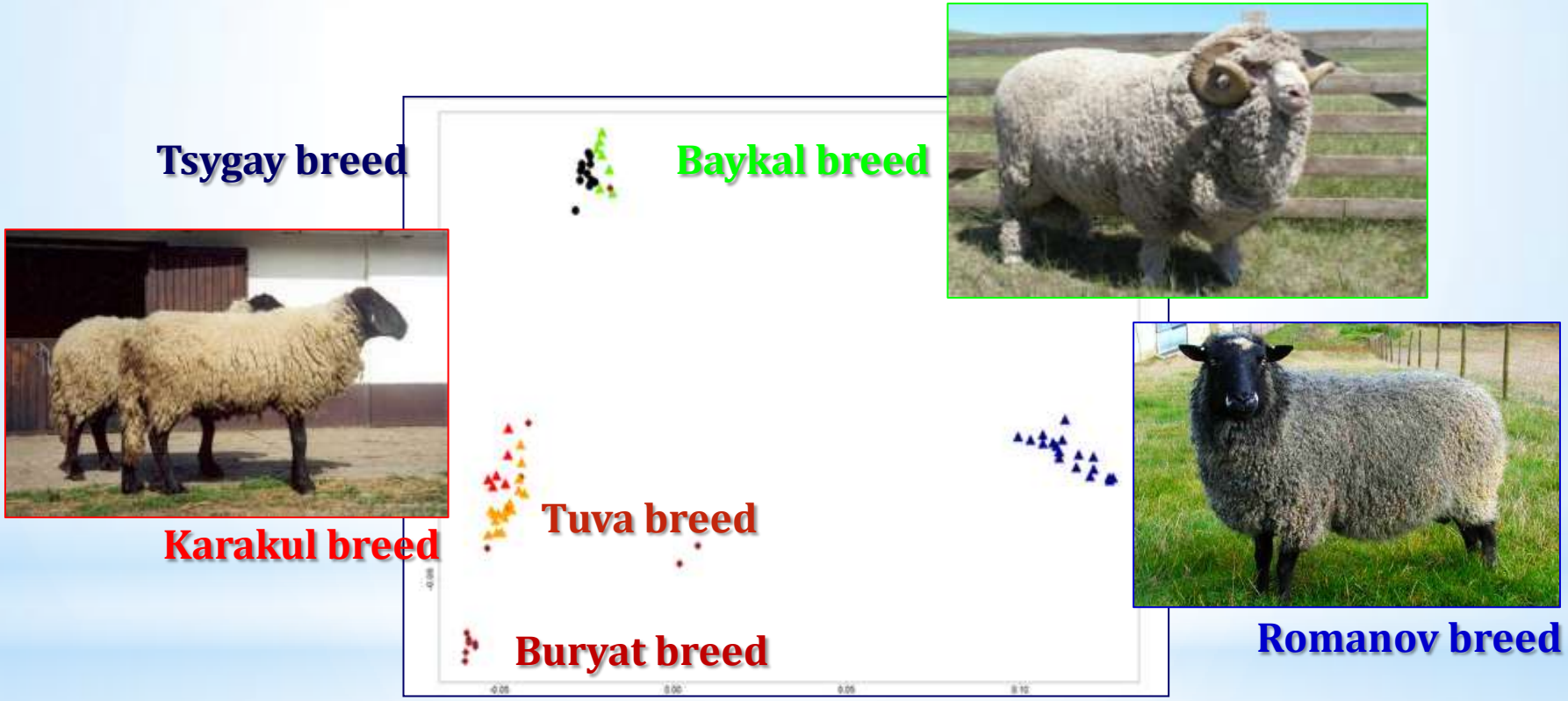


Fig. 2. – Differentiation of Russian sheep breeds based on the whole-genome SNP analysis

RESEARCH RESULTS (3)

The biodiversity of semi-domesticated rein deer has been studied. For the fist time, the application of whole-genome SNP BeadChips, developed for domestic animals (cattle and sheep) to study the rein deer diversity was shown (research results were published in J. of Heredity)

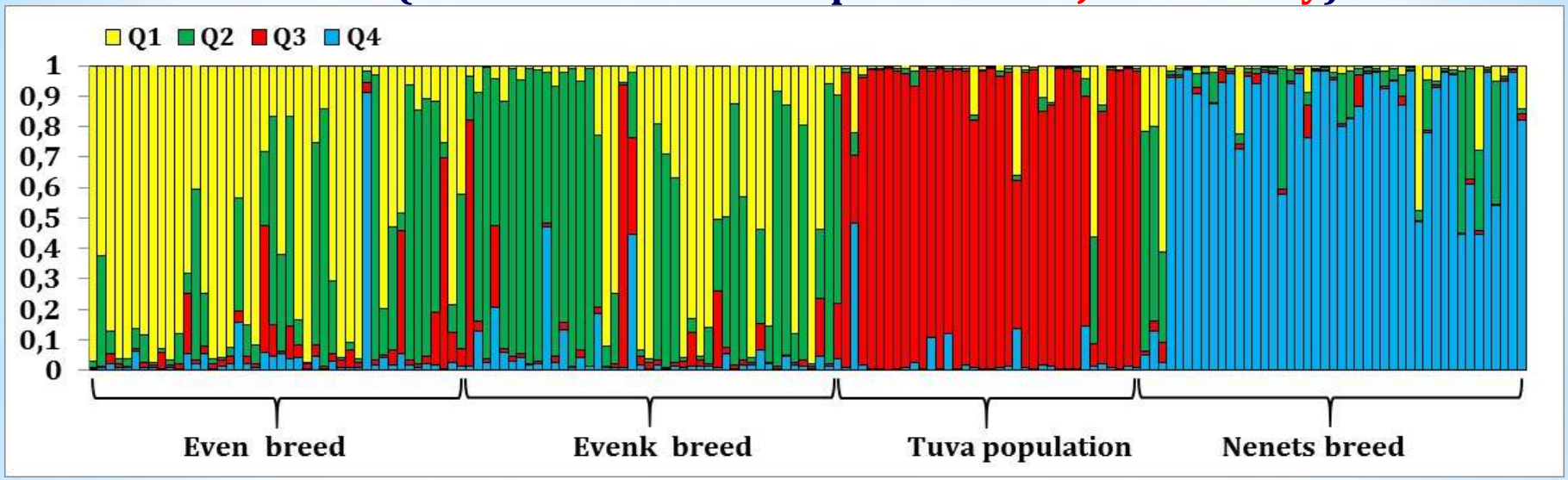
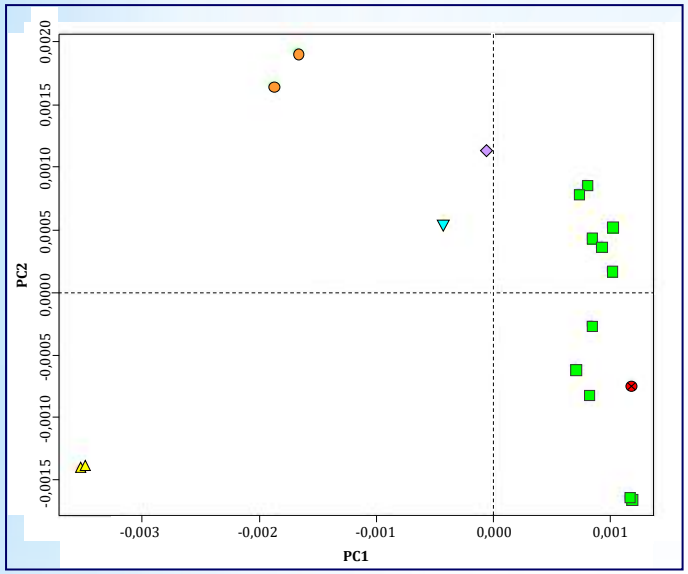


Fig. 3. – Differentiation of semi-domesticated rein deer breeds based on microsatellites

RESEARCH RESULTS (4)

For the fist time, the whole-genome SNP studies of snow sheep have been performed. Genetic differentiation of different geographical populations (inhabiting the different mountain ridges of Republic Sakha – Yakutia) of snow sheep was shown.



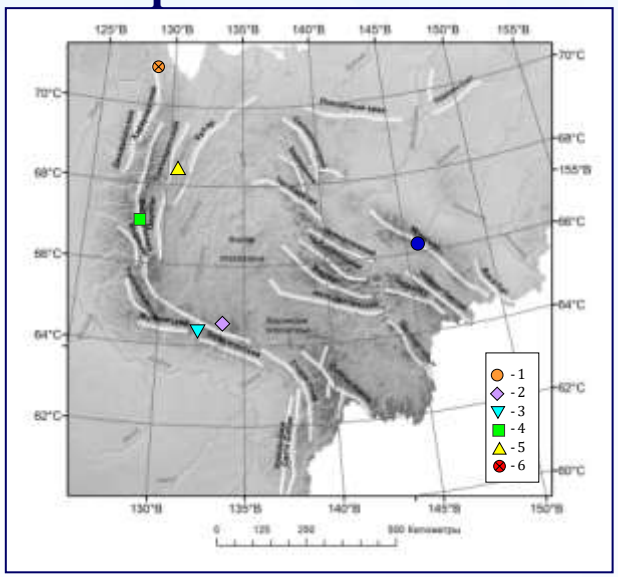


Fig. 4. Mountain ridges: 1 – Momskiy 2, 3 – Verkhoyanskiy; 4 - Orulgan; 5 - Sietindenskiy; 6 – Kharaulakhskiy

RESEARCH RESULTS (5)

Using hybridization of domestic and wild sheep species the founders and line-founders of the new types of animals were produced; the cryological collections of genetic materials (semen) were created

Name (ID) of rams	The quantity of sperm doses
FOUNDERS OF THE NEW SHEEP TYPES (F_1 HYBRIDS)	
Pamir (*Romanov sheep * Argali)*	>500
Mal'chik (*Romanov sheep * Snow sheep*)	>500
Snezhok (*Argali * Snow sheep*)	>500
FOUNDERS OF GENEALOGICAL LINES (F_2 HYBRIDS)	
5 breeding rams *(Romanov sheep * Pamir)*	>2500

RESEARCH RESULTS (6)

The significant higher growing capacity of the new sheep type comparing to Romanov sheep was observed. It was shown that the increased growing potential is achieved due to higher efficiency of nutritional digestions of the forage.

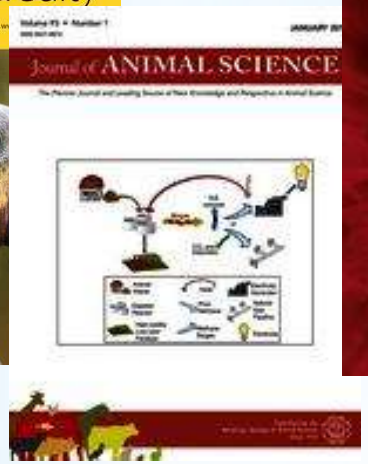
The significant differences in nutritional content of meat (muscle and fat tissues) of new sheep type comparing to Romanov sheep was observed:

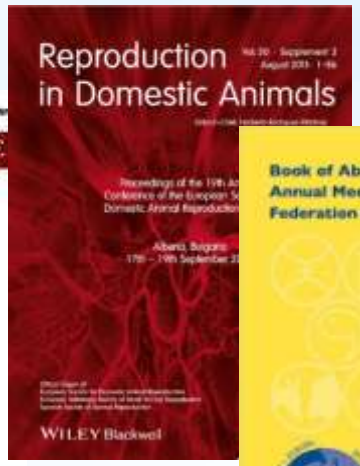
Alteration in muscle fiber ratio: the higher content of "white" fibers in the meat of new sheep type comparing to Romanov sheep

Decrease in content of saturated (and increase of non-saturated) fatty acids in the muscle and fat tissues of hybrid animals comparing to Romanov sheep

Fatty acids (FA)	Fat tissue, %		Muscle tissue, %	
	I	II vs. I	I	II vs. I
Saturated (SFA), incl.	55.1	-12.2*	53.4	-11.2**
- palmitic (C16:0)	27.7	-13.5***	27.0	-13.3***
Poly-non-saturated, incl.	10.1	+0.6	9.4	+4.1*
- linoleic (C18:2)	5.6	+0.5	5.5	+3.0*
Mono-non-saturated, incl.	28.8	+9.4*	34.2	+4.7*
- oleic (C18:1)	20.4	+9.6**	25.1	+7.2**

17 works are published in leading scientific journals on the results of the project in 2014-2016.





The results are presented in 11 scientific conferences, including:

15th Ann. Meeting of the American Society of Animal Science	USA, 07.15
14th International Arctic Ungulate Conference	Norway, 08.15
66th Ann. meeting of Eur. Federation of Animal Science (3 reports)	Poland, 08.15
19th Ann. Conf. of Eur. Society for Domestic Animal Reproduction	Bulgaria, 09.15
2nd Int. conference «Genetics and biotechnology of the XXI century»	Belarus, 10.15

Thank you for your attention!