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THE POSSIBLE ASSOCIATION OF STRUCTURAL CHROMOSOME ABERRATIONS WITH REPRODUCTIVE DISTURBANCES IN THE BREEDING PIG

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Cytogenetic research published here and abroad indicates that, besides the recognized causes of the reproductive disturbances in pig breeding, certain structural changes in the chromosomes may also influence reproduction. Therefore, the karyotype of swine of each sex from several farms were analyzed. The following disturbances in reproduction were noted: frequent abortion, appearance of mummified foetuses, small litters, avital offspring, bad quality of sperm, necrospermia, offspring with anomalies and a high percentage of stillbirths. The target of this investigation was to detect structural changes in chromosomes and to evaluate the relationship of any aberrations to the disturbances in reproduction. A control group of animals with an orderly reproductive cycle was also included.

Structural changes were observed in the chromosomes of four samples in the experimental group ranging from 2% of the examined cells to changes constitutional in the genome. For some of the aberrations especially reciprocal translocations it can be concluded by analyzing the offspring that the disturbance in reproduction is associated with the chromosomal aberration.

Key words: pigs, chromosome, karyotype, structural changes, reciprocal translocation, reproduction disturbance.

INTRODUCTION

The production process in intensive breeding of swine may be placed under economical control only if the discoveries and possibilities of certain scientific disciplines are used properly. The intention of this paper was to assess the possibility of solving some problems in reproduction using veterinarian cytogenetics. It is known that genetic and paragenetic factors influence every stage of the reproductive cycle. Therefore it is necessary to investigate them by contemporary scientific methods.

Problems of reproduction may be a consequence of raising animals in closed facilities without a proper scientific approach in choosing the breeding material. Besides selection for desired qualitative and quantitative characteristics, it is important to choose breeding material with a healthy genome to achieve the maximal reproductive performance. The chosen animals must have a normal karyotype without numerical and structural changes in their chromosomes. In countries with well developed cattle breeding there are regulations for obligatory cytogenetic attestation of breeding animals as an important measure to prevent certain disturbances in reproduction, (Ernst and Zhigachev, 1990). This is because the genome of living organisms is influenced by abiotic and biotic factors that may be genotoxic mutagenic or cancerogenic. Damage to chromosomes may be numerical or structural and they cause disturbances in reproduction whether they appear *"de novo"* or are transferred from parent to offspring. Numerical changes in chromosome sets are rare in animals, though there are a large number of data suggesting that they influence embryo mortality (Switonski et al., 1991), (Hare and Singh, 1979). Structural changes in chromosomes occur more often in animals. Information in the literature indicates that they affect reproduction. Therefore, we investigated the structural changes in chromosomes in breeding swine on our farms and their influence on reproduction.

MATERIAL AND METHODS

For this cytogenetic investigation we took samples from swine 20 of different sex, with registered disturbances in reproduction and 20 samples from a control group without the relevant disturbances. Data about both groups are presented in Table 1.

The chromosome were obtained from lymphocytes of peripheral blood. Cell cultures of lymphocytes were set up according to the method of Moorhead et al. (1960), and the G-banding technique according to Seabright (1971). Five preparations were made for each animal; karyotypes were analyzed for structural aberrations on 100 metaphase figures. Characteristic microphotographs were enlarged 1000 times on a phase-contrast and fluorescent microscope (Olympus BX 40).

Chromosomes were analyzed according to the international standard for karyotypization of domestic animals (Gustavsson et al., 1988, Ford et al., 1980).

RESULTS AND DISCUSSION

Structural changes in chromosomes were detected in the experimental group in four animals (Table 2). Among 100 metaphases examined changes were observed in 3% to 76% of the cells.

Sample No 2 with tattoo mark No. 20064 exhibited a disturbance in reproduction characterized by frequent insemination of female animals fertilized by sperm from this boar. The karyotype in 38 % of the analyzed cells showed a

Table 1. Data about reproductive disturbances in the experimental and control group

EXPERIMENTAL GROUP				CONTROL GROUP			
No	Tattoo	Sex	Reproductive disturbances manifested	No	Tattoo	Sex	Facts about reproduction
Swine farm - 1							
1	22865	M	Small litter X=6,5	1	22464	M	
2	20064	M	Frequent insemination of females	2	34297	M	Animals in the control group had regular reproductive cycles
3	22039	M	Small litter x =6,2	3	64437	M	
4	43586	M	Stillborn piglets	4	55678	M	Mean number of 10,5 vital offspring in a litter.
5	14556	M	Occasional necrospermia	5	55762	M	
6	6041	M	One anomaly registered in offspring	6	55477	M	
Swine farm - 2							
7	2246	F	Frequent insemination	7	2245	F	Parturition without stillborn piglets
8	0237	F	Previous farrowing with vital offspring	8	0269	F	Regular oestrus reaction
9	0224	F	Small litter x=6	9	2153	F	Normal sexual behaviour
Swine farm - 3							
10	41631	F	Frequent insemination small litter	10	57868	F	Offspring without anomaly
11	65691	F	Insemination	11	65096	F	Good sperm quality
12	77210	F	Degenerated offspring	12	68133	F	
13	16480	F	Dead litter	13	84484	F	
Swine farm - 4							
14	02281	M	10% deformed offspring	14	02251	M	
15	02220	M	Excluded	15	8228	M	
16	29413	M	Small litter X=6	16	17677	M	
17	02226	M	Necrospermia	17	02224	M	
18	02199	M	Reduced libido	18	02221	M	
Swine farm - 5							
19	51845	M	Small litter X=6.1	19	60917	M	
20	56991	M	Excluded	20	59610	M	

Table 2. Structural changes in chromosomes of the experimental group of animals

R/b	Tattoo-ing No.	No. of analyzed metaphases	TYPES OF CHROMOSOME ABBERATION															
			Deletion		Translocation		Inversion		Duplication		Fragments		GAP Interruption		Deviation from morphology		Narrowing	
g			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	22865	100																
2	20064	100															38	38
3	22039	100																
4	43586	100			73	73							2	2	1	1		
5	14556	100																
6	6041	100																
7	2246	100																
8	0237	100											4	4				
9	0224	100																
10	41631	100																
11	65691	100																
12	77210	100																
13	16480	100																
14	92281	100																
15	02220	100	2	2							1	1						
16	29413	100																
17	02226	100																
18	02199	100																
19	51845	100																
20	56991	100																

narrowed q-arm on chromosome 1 compared with the homologous chromosome pair in the distal part of the second region (band 6, 7, 8). The offspring of this sample, at the beginning of reproductive exploitation did not manifest changes in karyotype. Detailed analyses of the state of health and checking the records of therapy indicated frequent virus infections that may be related to the "*de novo*" structural narrowing of one chromosome of the first pair (Kuzmanović, 1974, Tzocheva K. 1994).

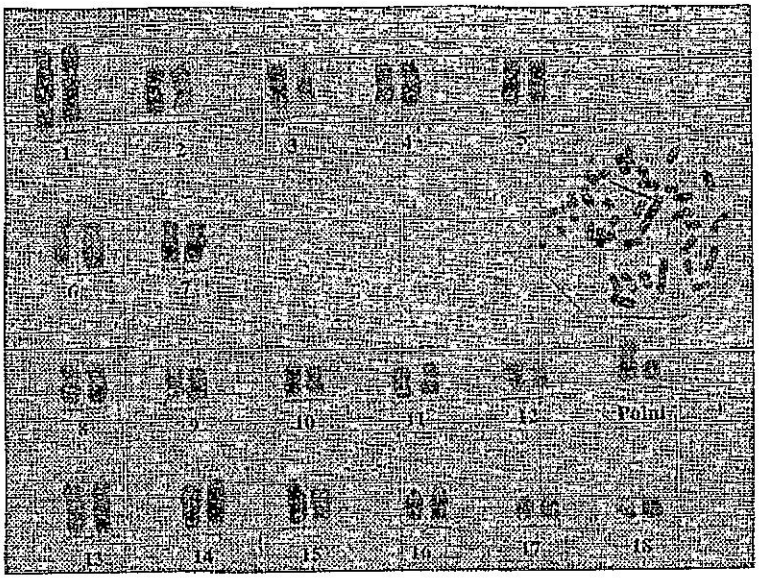

Figure1. Karyogram and karyotype of animal No. 20064, Isthmus q arm of the first chromosome

The appearance of "*de novo*" structural change in the domestic pig and its influence on reproduction was reported by Konfortova et al.(1995). The phenomenon of "*de novo*" structural changes in chromosomes may be a consequence of biotic and abiotic factors in intensive breeding of swine (Soldatović and Zimonjić, 1986, Soldatović and Stanimirović, 1988, Košarčić et al., 1996).

Sample No 4 with tattoo mark No. 43586 exhibited a reciprocal translocation between one of the homologous chromosomes of the first pair on the q-arm in region 2. The dislocated part of the q-arm of the 15^{th} chromosome with fragments of strips 6, 5, 4 was transferred. This reciprocal translocation type $1q^{+}$; 15 q, was found in 73% of the examined cells.

Besides this structural change morphological deviation was discovered in the same animal in the form of crossed chromatids of both chromosomes of the 15^{th} pair in 1% of the examined cells and a break of one chromosome in the fourth pair in 2%.

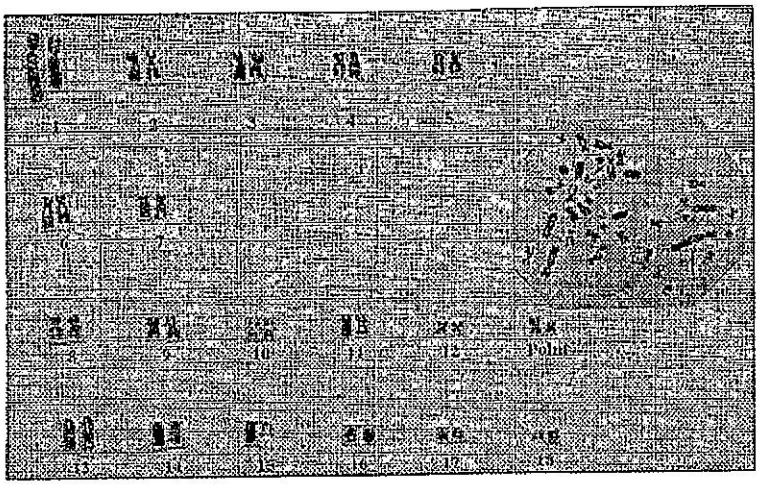

Figure 2. Karyogram and karyotype of animal No. 43586, reciprocal translocation lq+ ; 15q

A stillbirth was noted in two records. There were also litters with only a few piglets that survived. This type of structural phenomenon has often been mentioned as an important factor in reproductive disturbances, especially concerning litter size (Villagomez et al., 1993, Zhang et al. 1992). Kuokkanen and Häkinen (1988) described a similar reciprocal translocation. It occurred between the first and the fifteenth chromosome only on one fragment of the q-arm in the same order and number of strip translocation on the p-arm, while in our example it was on the q-arm. In the genome of this animal 2% of the cells had a break on the q-arm of one homologous chromosome of the fourth pair. A total of 1% of the cells showed crossed chromatids of chromosome No. 15. This experimental animal was excluded from reproduction, although the phenotype was good. However, according to the karyotype and the litter size the number of offspring was not profitable for production.

The sample with tattoo No. 0237 had a structural break of the q-arm chromatid of one homologous chromosome from the third pair and in 4% of the examined cells. This percentage of structural changes is within the limits according to the international tolerance of the percentage of damage to the genome (Bakaj et al. 1985). In the sample with tattoo No. 02220 a structural change was observed as a deletion on the terminal part of the q-arm of one chromatid of one homologous chromosome of the first pair in 2% of the cells. This structural change of the isochromatid break of chromosome No. 15 occurred in 1% of the examined cells. Necrospermia was detected in this animal.

No structural aberrations on the chromosomes in the control group of animals was discovered except for 1% polyploidy in 2 samples that can be tolerated as appearing during cultivation of the lymphocyte cells.

From the results obtained for the karyotype of the samples with registered disturbances in reproduction, we can state that the constitutional change of the karyotype with the reciprocal translocation affected the litter size and the number of stillbirths (Popesku and Legault, 1979, Popesku and Bocher, 1982, 1986, Popesku et al., 1988). After analyzing other factors that could influence reproduction and their exclusion, we find that this structural aberration influenced reproduction.

The other changes detected in the structure of chromosomes in three experimental animals were not constitutional changes because they occurred in 3% - 38% of the examined cells. It cannot, therefore be stated with certainty that they cause problems in reproduction. However, it is important to stress that these are breeding animals and the period of reproductive exploitation is very long on our farms so exclusion is recommended if changes in chromosomes appear.

Researchers advise that a cytogenetic attestation should be done for breeding animals. In countries with well-developed production it is regulated by law.

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UTICAJ STRUKTURNIH HROMOZOMSKIH ABERACIJA NA POREMEĆAJ REPRODUKCIJE PRIPLODNIH SVINJA

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