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KARYOTYPE DISTRIBUTION IN A CHOSEN HERD OF THE ARCTIC FOX[1] (*ALOPEX LAGOPUS*)

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Summary. Cytogenetic investigations were carried out on 138 foxes (91 females and 47 males) originating from one farm. Three karyotype forms were found. The normal karyotype and two polymorphic forms ($2n=49$ and $2n=48$) resulting from centric fusion translocation occurred at the frequencies of 25.4%, 36.2% and 38.2%, respectively. An analysis of the centric fusion effect on the fertility of females showed that the mean litter size of homozygous females with $2n=48$ was significantly larger than that of females with 49 and 59 chromosomes. The litter size of females with 48, 49 and 50 chromosomes was 11.0, 9.8 and 9.3, respectively.

The arctic fox is one of few species, the population of which with regard to karyotypes does not constitute a uniform group and consists of individuals with the diploid chromosome number 50, 49 and 48. The basic chromosome number for *Alopex lagopus* is $2n=50$. Two remaining polymorphic forms frequently occurring in that species, i.e. $2n=48$ and $2n=49$, are a result of translocation of the centric fusion type between two pairs of acrocentric chromosomes. This translocation, called Robertsonian, was observed for the first time by Gustavsson (1965) in foxes from Swedish farms. Karyotypic polymorphism of that kind, as well as a similar distribution of the chromosome number in a population was found in arctic foxes bred in Finland and in Poland (Świtoński 1980, Mäkinen et al. 1981). Relationships between the chromosome centric fusion and its carriers have not been sufficiently studied so far. The purpose of the present studied was to obtain data about the distribution of Robertsonian translocation and its influence on the fertility of foxes from a chosen herd and their eventual use in reproduction.

MATERIAL AND METHOD

The karyotypic studies covered the basic herd of arctic foxes of the farm PLL "Las" at Skolimów consisting of 91 females and 47 males. Chromosome preparations were made by the generally accepted method from the lymphocytes of blood

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cultured for 72 hours in the medium consisting of Eagle's medium, calf serum added with antibiotics and a mitogenic agent of phaseoline or phytohemagglutinin. The preparations were stained by routine method. Twenty metaphase plates from each animal were examined under a microscope to determine the karyotype of individual animal. The influence of translocation on the fertility of females was estimated on the basis of their litter size (the number of live and dead-born cubs). It was difficult to estimate the litter size depending of the karyotype of father because the females were mated several times with different males.

The significance of differences between the means of the litter size of three karyotypic groups of females was estimated using the variance analysis and *t*-test.

RESULTS AND DISCUSSION

The distribution of karyotypes in females and males is given in Table 1.

From Table 1 it follows that foxes with the normal chromosome number $2n=50$ constitute the minority of the herd. Foxes being translocation heterozygotes with the chromosome number $2n=49$ and translocation heterozygotes with the chromosome number $2n=48$ constitute totally 74.5% of the herd. These both translocations forms occur at a similar frequency. These results are in agreement with the data obtained by Świtoński (1980). A somewhat different karyotype distribution in foxes from Finnish and Swedish farms was given by Mäkinen and Gustavsson (1980). The normal karyotype ($2n=50$) was dominant at these farms and translocation homozygotes ($2n=48$) constituted the lowest per cent (only 9.8% of the herd).

Table 1. Distribution of the chromosome number in females and males of the studied herd of arctic foxes

Karyotype	Total No. of animals	Females		Males	
		No.	per cent	No.	per cent
$2n=50$	35	23	25.3	12	25.5
$2n=49$	53	37	40.6	16	34.0
$2n=48$	50	31	34.1	19	40.4

Table 2 gives the average litter size at birth in females with the normal karyotype ($2n=50$) and with translocations in a heterozygous ($2n=49$) and homozygous state ($2n=48$). It follows from the analysis that females with the normal karyotype ($2n=50$) had litters of the smallest size, on average 9.30 cubs per litter. The largest litters (numbering 11 cubs) were obtained from females with $2n=48$. Differences in the litter size between this group of females and a group of females with the karyotype $2n=50$ are statistically significant ($P<0.05$). It should be noticed that the average litter size in individual karyotypic groups of females was calculated on the basis of all the litters, which were given by females during their life. It is known, however, that the first litters in foxes are smaller than the next ones. Differences in the average litter size occurring between the studied groups of females, however, were not caused by a larger or smaller portion of the first litters in the total number of analysed

litters. The first litters constituted 46.6% in the total number of analysed litters in females with the karyotype $2n=48$ and 42.3% in each of the remaining groups of females. The average number of cubs calculated on the basis of the first litters in females with 48 chromosomes was 11.1, and 9.7 and 8.2 — in females with 49 and 50 chromosomes, respectively.

Table 2. The litter size in the females of three karyotypic groups of the studied herd of arctic foxes

Karyotype of females	No. of litters	Average litter size and standard deviation
$2n=50$	26	$9.30+3.0^{a}$
$2n=49$	59	$9.83+2.75^{b}$
$2n=48$	45	$11.00+2.59^{ab}$

^{ab} means marked with the same letter differ significantly at $P<0.05$

The literature concerning the influence of Robertsonian translocation on the fertility of foxes is not too rich, except studies conducted by Świtoński (1980, 1981). That author reports that in the studied by him herds, the largest litters were obtained from females with the karyotype $2n=48$, whereas the smallest litters were obtained from females of translocation heterozygotes ($2n=49$). In the present studies, however, translocation heterozygotes gave smaller litters than homozygotes, but these litters were a little larger than those of females with the normal karyotype. Besides that, in our studies the average litter size was calculated only for parturient females, whereas infertile females or abortions were not taken into consideration thinking that the environment has a larger influence on that state of things than genetic factors, which can explain certain differences in the comparable results. The obtained data indicate a favourable effect of Robertsonian translocation on the fertility of females of the studied herd. This phenomenon is difficult to explain, the more so as in some animal species Robertsonian translocations negatively influence the fertility of their carriers (Gustavsson 1969, Refsdal 1976) as a result of the formation of gametes with unbalanced karyotypes and, consequently, of aneuploid zygotes (King et al. 1980, Popescu 1980). In view of the above, further studies are necessary to elucidate this problem, since it is greatly important not only for knowledge, but also for practice, and in the conditions of increasing costs of fur animal maintenance any possibility to improve their fertility and productivity is desirable from economic views.

CONCLUSIONS

1. It was found that in the cytogenetically studied herd of arctic foxes numbering 138 individuals (91 females and 47 males) 25.4% of foxes had the normal karyotype $2n=50$. The remaining two polymorphic forms with the karyotype $2n=49$ and

$2n=48$ constituted 36.2% and 38.4%, respectively, of the number of animals in the herd.

2. It was found that females with centric fusion in a homozygous state ($2n=48$) gave larger litters (11.0 cubs) than did females with translocation heterozygotes (9.8 cubs) and females with the normal karyotype (9.3 cubs).

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ROZKŁAD KARIOTYPÓW W WYBRANYM STADZIE LISÓW POLARNYCH (*ALOPEX LAGOPUS*)

Streszczenie

Przebadano cytogenetycznie stado podstawowe lisów polarnych fermy PPL „Las" w Skolimowie pod względem rozkładu kariotypów oraz zależności między kariotypem matki a liczebnością miotu przy urodzeniu. Określono kariotypy 91 samic i 47 samców. Kariotyp $2n=50$ stwierdzono u 23 samic (25,3%), kariotyp $2n=49$ wystąpił u 37 lisic (40,6%), natomiast komplet 48 chromosomów miało 31 (34,1%) samic. Samców z kariotypem 50, 49, 48 było odpowiednio 12 (25,5%), 16 (34,1%) i 19 (40,4%). Najmniej liczną grupę w stadzie (25,4%) stanowiły lisy z kariotypem normalnym $2n=50$. Dwie pozostałe formy polimorficzne, tj. heterozygoty translokacyjne z liczbą chromosomów 49 i homozygoty z 48 chromosomami stanowiły odpowiednio 36,2% i 38,4% stada. Największą liczbę młodych w miocie (średnio 11,0 sztuk) stwierdzono u lisic z 48 chromosomami, natomiast u samic z 49 i 50 chromosomami średnia wielkość miotu wynosiła odpowiednio 9,83 i 9,31 szczeniąt.

РАСПРЕДЕЛЕНИЕ КАРИОТИПОВ В ВЫБРАННОМ СТАДЕ ПОЛЯРНЫХ ЛИСОВ (*ALOPEX LAGOPUS*)

Резюме

Основное стадо полярных лисов государственной фермы „Лес" в Сколимове исследовалось цитогенетически относительно распределения кариотипов, а также зависимости между кариотипом матери и величиной мёта при рождении. Были определены кариотипы у 91 самки и у 47 самцов. Кариотип $2n=50$ был обнаружен у 23 самок (25,3%), кариотип $2n=49$ выступил у 37 лисиц (40,6%), а комплет 48 хромосом имело 31 самка (34,1%). Самцов с кариотипом 50, 49, 48 было соответственно 12 (25,5%), 16 (34,1%) и 19 (40,4%). Численно наименьшую группу в стаде (25,4%) составляли лисы с нормальным кариотипом $2n=50$. Две остальные полиморфические формы, т.е. транслокационные гетерозиготы с числом хромосом 49 и гомозиготы с 48 хромосомами, составляли соответственно 36,2% и 38,4% стада. Наибольшее число молодых в мёте (в среднем 11,0 штук) было у лисиц с 48 хромосомами, а у самиц с 49 и 50 хромосомами средняя величина мёта составляла соответственно 9,83 и 9,31 щенка.