ANALYSIS OF THE GENETIC HISTORY OF THE PROLIFIC PALAS BREED

O.-C. Dordescu[1*], P.-G. Vicovan[1], R. Răducu[1], A. Vicovan[1], A.-G. Vartic[1], M. Stanciu[1], Ş. Creangă[2]

[1]*Research and Development Institute for Sheep and Goat Breeding Palas – Constanta, Romania*
[2]*Iasi University of Life Sciences, Faculty of Food and Animal Sciences, Iasi, Romania*

Abstract

The creation of a sheep breed with high prolificacy was necessary in the context where the improvement of the sheep meat production is dependent on the productive capacity of the breeds, so as to obtain a greater number of lambs from a ewe in a system of complex crosses, involving specialized meat breeds. To increase meat production in sheep, the Prolific Palas Breed was created at Research and Development Institute for Sheep and Goat Breeding Palas - Constanta for over 15 years, based on a complex program of crosses between the Palas Merino breed and imported prolific breeds. A multitude of combinations of Palas Merino with Romanov, Border Leicester, Île-de-France, East Friesian and Finnish Landrace breeds were tested, in 1989 obtaining the desired type. The newly created population has been reproductively isolated since 1990, self-breeding for 7 generations to date, aiming to maintain prolificacy above 150%, a high lactation capacity and an increase inbreeding per generation below 1%. The Prolific Palas Breed was approved in 2020. The analysis of the genetic history of the breed was made on the four random lines of the pedigrees, extracted from the Genealogical Register of the Palas High Prolific Line and there were calculated the genetic similarity, inbreeding coefficients and relatedness itself. The Prolific Palas Breed is 39.07% similar to the Romanov breed, 28.13% to the Merino breed, 15.63% to the East Friesian breed, 9.36% to the Border Leicester breed, 6.25% to the Île-de-France and 1.56% with Finnish Landrace breed. The intergenerational interval on father-son and father-daughter lineages was 3.49 and 3.94 years, respectively. Total inbreeding was 4.39%, inbreeding per generation 0.57%, current inbreeding (incest) being 0.0%, and the average number per generation 7.71.

Key words: *sheep, genetic analysis, Prolific Palas Breed*

INTRODUCTION

In the conditions in which the demand on the national and international market for products and by-products from small ruminants is continuously increasing, it was resorted to the creation of a new romanian breed of sheep with a high prolificacy, well adapted to the environmental conditions of the lowland areas.

At Research and Development Institute for Sheep and Goat Breeding Palas, the Prolific Palas Breed was created with a view to improving the meat production of sheep, taking into account the improvement of the reproductive capacity so as to obtain a higher number of lambs per ewe in a complex mating system, at which can also participate in specialized breeds of meat (Vicovan et al. 2017).

The Prolific Palas Breed was approved in 2020, currently at the Research and Development Institute for Sheep and Goat Breeding Palas - Constanta, with a total flock of 431 sheep, of which 274 ewes, 49 rams and 108 lambs, also delivering annually about 150 rams, contributing to the creation of daughter herds in the lowland areas.

An important aspect is that the breed can produce rams sired by highly prolific hybrid ewes, which by crossing with meat rams produce triracial hybrid lambs with high growth rate and quality carcasses, classified according to conformation in class U2-3 (good, lean and medium fat carcasses) of the EUROP grid (Cassas et al. 2004).

MATERIAL AND METHOD

The Prolific Palas Breed was formed in the period 1973-1988 through a complex program of crosses between the Palas Merino breed and imported prolific breeds, when sheeps of the "desired type" were obtained, which had 38% genes from the Romanov breed in the genome, 28 % Palas Merino genes, 16% East Friesian genes, 9% Border Leicester genes, 6% Île-de-France genes and 2% Finnish Landrace genes (Jakubec et al. 1977; Kukovics, 1986; Vicovan et al., 2020).

The population has been reproductively isolated since 1990, self-breeding for 7 generations, during which selection was aimed at maintaining over 150% prolificacy, a high lactation capacity and an increase in inbreeding below 1%.

The analysis of the genetic history of the breed was made on the basis of the pedigrees of four random lines, extracted from the Genealogical Register of the Palas High Prolific Line, according to the procedure established by Wright S. in 1925 and Robertson A. in 1951. Calculation of genetic similarity, coefficients of inbreeding and kinship itself was carried out according to the method of Wright, Lush and Robertson, synthesized by Draganescu in 1970 (Draganescu, 1970; Robertson et al. 1951; Wright, 1949).

RESULTS AND DISCUSSIONS

In the period 1973-1988 the value of the Reproductive Isolation Coefficient (RIC) was -1, resulting the fact that the population was opened, being used for reproduction rams of several breeds until the "desired type" was obtained. Starting from 1989 and up to the present, the reproductive isolation of the breed was total, the RIC value being +1 (Table 1).

Table 1 Evolution of reproductive isolation in the Prolific Palas Breed

Specification	1973	1978	1988	From 1989 to the present
Reproductive Isolation Coefficient (RIC)	-1.0	-1.0	-1.0	+1.0

To establish the genetic similarity with each of the founding breeds, the following formula was used:

$$\text{Similarity to breed X} = \frac{\text{Number of occurences in the pedigree of X breed}}{\text{Number of pedigrees analyzed x 4}}$$

The Prolific Palas Breed is 39.07% genetically similar to the Romanov breed, 28.13% to the Palas Merino breed, 15.63% to the East Friesian breed, 9.36% to the Border Leicester breed, 6.25% to the Île-de-France and 1.56% to the Finnish Landrace breed (Table 2).

Table 2 Genetic similarity of the Prolific Palas Breed to the parent breeds

Breed	Genetic similarity of individuals born in 2015-2017 to the founder breeds (%)		
	Rams	Sheep	Total population
Romanov	38.46	39.22	39.07
Palas Merino	27.08	28.44	28.13
East Friesian	18.69	14.73	15.63
Border Leicester	12.31	8.51	9.36
Île-de-France	2.92	7.23	6.25
Finnish Landrace	0.85	1.77	1.56

In the succession of more than 7 generations of reproductive isolation of the line, a multitude of rams were used in breeding to avoid increasing inbreeding by more than 1% per generation.

In 1989, the Prolific Palas Breed was genetically similar in proportion of 10.74 – 12.85% to two Romanov rams with numbers 185 and 14 and in proportion of 5.14 – 8.41% to four rams with numbers 502, 20394, 90804 and 30793.

An important ram is considered to be that ram with which the population is genetically similar to at least 5%. The data presented in Table 3 show that there were two important ram, namely rams 97127 g^3 and 97049 g^3 with which the breed is genetically similar in proportion 8.77 % and 5.26 % respectively.

Table 3 Genetic similarity of the Prolific Palas Breed with major rams

No.	Ram (registration number)	Year of birth	Genetic similarity with important rams
1.	97127g^3	1989	8.77
2.	97049g^3	1989	5.26

The interval between generations on father-son and father-daughter lineages was 3.49 years and 3.94 years, respectively, lower than the interval on mother-son lineages, which was 5.18 years and 5.12 years, respectively for mother-daughter. The average for total lineages was 4.49 years (Table 4).

The size of the interval between generations in this breed reveals the fact that in the evolution of the generations, young sheep that came from older ewes that had to have at least 5 products in the first 3 lambings were retained for reproduction.

Table 4 Evolution of the interval between generations in the Prolific Palas Breed

Specification	Father - son	Father - daughter	Mother - son	Mother - daughter	Media
Intergenerational interval (in years)	3.49	3.94	5.18	5.12	4.49

Self-relatedness of a population (breed) is the average relatedness among all individuals and is due to reproductive isolation, its limited size and selection. The individuals of a population (breed) are at all times related to each other, that is, they come from a series of previously existing common ancestors (in descent).

The kinship itself is calculated in the analyzed years on the pedigree of 4 random lines, according to the formula:

$$R = \frac{N}{N_p} \times 100, \text{ where:}$$

N – the number of couples – maternal pedigrees in which a common ancestor was found (this assumes that in each pedigree the father's side is compared with all the mothers' parts in the other pedigrees, less the mother's side in the pedigree in question);

N_p – the possible number of pedigree couples of 4 random lines, where:

N_p = 4 x pedigree number x (pedigree number – 1).

Following the subdivision of the race and the works carried out, it was observed (Table 5) that the Prolific Palas Breed has the relatedness itself of 0.96%.

Table 5 Inbreeding, genetic size and effective number of males in the Palas Prolific Breed

Specification	Medium values
Relatedness itself (%)	0.96
Total inbreeding (%)	4.39
Non-current inbreeding (%)	4.39
Current inbreeding – incest (%)	0.00
Inbreeding per generation (%)	0.57
Possible inbreeding (%)	0.46
Line inbreeding (%)	3.47
Average number of generations	7.71
Effective size (N_e)	87.72
Effective number of males (N_m)	21.93
The optimal number of males	12

Total inbreeding is 4.39% and current inbreeding (incest) is 0.00%.

Inbreeding over generations has the value of 0.57%.

The possible inbreeding is calculated by the formula: $\frac{R}{\frac{2}{R}}$, where R represents the relatedness of the population itself.

The possible inbreeding has the value of 0.46%.

Line inbreeding has the value of 3.47%.

The average generation number of the breed is 7.71.

A comparative analysis with the data on the inbreeding of the population before the year 1990 reveals that the kinship itself decreased from the value of 7.10% to 0.96%, and the inbreeding per generation decreased from the value of 0.96% to 0.57%. This means that more and more rams were used in the generation dynamics to avoid increasing inbreeding by more than 1% per generation.

The genetic size (N_e) is given by the formula $N_e = \frac{1}{2 \times \Delta F} \times 100$, where ΔF is the inbreeding per generation.

Thus, $N_e = \frac{1}{2 \times 0.57} \times 100 = 87.7192$ individuals.

The effective number of males (N_m) in the Prolific Palas Breed is 21.93 and was calculated according to the formula:

$N_m = \frac{1}{8 \times \Delta F}$.

The Prolific Palas Breed has a mesomorphic to dolichomorphic body shape with fine, strong bone and correct position of legs. The head is broad, of medium size, the profile straight in sheep and slightly convex in rams. The neck is suitably long, carried horizontally and well attached to the body and the trunk is long, of medium width and depth. The wool is semi-fine, some specimens have fine, white wool, and the husk does not present colored fibers (Radu et al. 2018).

The udder has a globular shape, of medium to large size, the nipples being appropriately long, carried vertically or slightly laterally. The average total milk production exceeds 180 liters.

After shearing, rams have an average body weight of 74.58 kg, and ewes 50.22 kg. In males and females, the average body weight is 56.95 kg and 44.25 kg, respectively. The average amount of sheared wool is 4.63 kg for rams, 2.82 kg for sheep, and 4.15 kg for ewes and 3.85 kg for ewes (Table 6).

Table 6 Average body weight by sex and average wool amount

Category	Weight after shearing (kg/head)	Amount of physical wool (kg/head)
	$X \pm s_x$	$X \pm s_x$
Rams	74.58 ± 1.2538	4.63 ± 0.1915
Ewes	50.22 ± 0.3943	2.82 ± 0.0307
Young rams	56.95 ± 0.7059	4.15 ± 0.1284
Young ewes	44.25 ± 0.5717	3.85 ± 0.0847

Table 7 shows the growth dynamics of lambs during the lactation period and in fattening conditions, from which it can be seen that male lambs had an average birth weight of 3.36 kg, and females 3.23 kg. At weaning at 80 days, males weighed 20.53 kg and females 19.72 kg, achieving average daily growth gains of 214.63 and 206.13 g and demonstrating high weight gain performance.

Table 7 Growth dynamics of the Palas Prolific Breed lambs during the lactation period

Category	Body weight (kg/head)		Average age at weaning (days)	Average daily growth rate (g)
	At lambing	At weaning		
	$X \pm s_x$	$X \pm s_x$		
Males	3.36 ± 0.0690	20.53 ± 0.3421	80	214.63
Females	3.23 ± 0.0334	19.72 ± 0.2759	80	206.13
Total	3.29 ± 0.0260	20.11 ± 1.6054	80	210.25

The main characteristic of the Prolific Palas Breed is the high value of prolificacy. The values of this indicator established in the lambing campaign 2021-2022 at R.D.I.S.G.B. Palas are presented in Table 8, where it can be seen that the prolificacy in primiparous ewes was 143.43%, and in multiparous ewes 153.80%, the average prolificacy for the entire herd being 151.13%, ewes weaning 1.40 lambs per ewe.

Table 8 Reproductive indices in the Prolific Palas Breed

Category	Lambs (heads)	Lambs obtained (heads)	Prolificacy (%)	Weaned lambs	
				%	On ewe (head)
Primiparous ewes	112	164	146.43	91.46	1.34
Multiparous ewes	199	306	153.80	92.81	1.43
Total sheep	311	470	151.13	92.34	1.40

CONCLUSIONS

The Prolific Palas Breed is the most prolific Romanian breed of sheep, which can contribute to increasing meat production, an important objective in the current economic context. With a remarkable adaptability to the arid environmental conditions in the south-eastern part of Romania, this breed retains its characteristics, the mother sheep weaning 1.4 lambs per ewe, 31% more than the Merino sheep. At the same time, the remarkable differentiation of individuals from the Prolific Palas Breed compared to the Palas Merino breed (domestic breed) in terms of body dimensions, especially in width, lead to the establishment of superiority in terms of meat production.

Another important aspect of sheep breeding is that triracial hybrid lambs well adapted to arid lowland conditions with high growth rate and high carcass quality can be obtained by mating Prolific Palas Breed rams with Merino ewes, obtaining F_1 hybridsheep, sheep that in the next stage can be mated with rams from breeds specialized for meat.

ACKNOWLEDGEMENTS

REFERENCES

1. Cassas E., Freki, A., Leymaster, KA (2004). Evaluation of Dorset, Finnishsheep, Romanov, Texel and Montadale breeds of sheep. II reproduction of F_1 ewes in spring mating seasons. Journal of Animal Science, no. 83, pp. 2743-2751.
2. Draganescu, C. (1970). Research on the methodology used in the practice of animal breeding in Romania. Thesis
3. Jakubec V., Krizek J. (1977). The fertility of prolific breeds Finnish, Romanov, East Frisian and their crosses with mutton Merino. Annals of Animal Genetics and Selection. 18th Session of Genetic Committee.
4. Kukovics, S. (1986). Use of highly prolific breeds and crossbreeding. FAO Animal Production and Health Papers – Proceeding of Expert Consultation, Rome.
5. Radu R., Jitariu D., Vicovan P.G., Zamfir C.Z., Enciu A., Pivodă C.A. (2018). Research and Development Institute for Sheep and Goat Breeding Palas – Constanța – past, present and future. Ed. Universitară, Bucharest.
6. Robertson A., Asker A.A. (1951). The genetic history and breed structure of British Friesian cattle. Empire Journal of Experimental Agriculture, nr. 19, p.113-130.
7. Vicovan P.G., Enciu A., Neacșu C., Vicovan A., Radu R. (2017). Researches regarding slaughtering output and carcass characteristics at crossbreeds F_1 Romanov x Palas Merino and F_1 Prolific Breed Palas x Palas Merino. International Journal of Science and Research, vol. 6 (1).
8. Vicovan P.G., Radu R., Enciu A., Vicovan A. (2020). New breeds of sheep created by scientific research from ICDCOC Palas Constanța. Ed. Celebris, Constanta.
9. Wright S. (1949). The genetic structure of populations. Annals of eugenics , no. 15 (1), p. 323-354.