GROWTH CHARACTERISTICS OF ROMANOV AND ROMANOV-RAHMANI CROSSBRED LAMBS IN EGYPT

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SUMMARY

Sheep growth characteristics as affected by breed group (Romanov, 1/2Rahmani1/2Romanov and 3/4Rahmani1/4Romanov) and non-genetic factors (sex, season of birth, year of birth, type of birth, dam age and number of weights) were studied.

Monthly weights were used to calculate growth curve parameters for each lamb using Brody's growth function $Y_t = A\ (1 - B\ e^{-Kt})$. Its derivatives in terms of instantaneous average growth rate (IGR) and amount of maturity remaining to be attained as a fraction of the weight already attained (AMRA) were estimated at 2, 6 and 12 months of age.

Least squares means for the growth curve parameters A, B and K were 44.26, 0.955 and 0.004, respectively, and their derivatives at 2, 6 and 12months of age were, respectively, 118, 69, 35% for IGR and 3.82, 1.22 and 0.47 for AMRA. R^2 was estimated as 98.9%. There were no significant effect of breed group on all studied growth characteristics except IGR at 6 month of age. The effect of sex was significant ($P<0.01$) only for A, B and for IGR at all ages. Season of birth had significant effect only on B ($P<0.01$) and only on IGR at 6 months and AMRA at 2 months ($P<0.05$). All growth characteristics were significantly ($P<0.01$) affected by year of birth and significantly ($P<0.05$) influenced by type of birth except A and IGR at 6 months. Age of dam did not show any significant effect on A,B or K and had significant ($P<0.01$) effect only at 2 months on IGR and AMRA and at 6 months on IGR.

***Keywords:* Growth, nonlinear growth function, Rahmani, Romanov, crossbred growth and maturity characteristics**

INTRODUCTION

Growth is a complex biological process that must be evaluated carefully to determine the suitably economic marketing time and to plan and monitor the appropriate management and genetic improvement programs. Knowledge relating mature weight to both birth weight and growth rate of various breed groups used for meat production should enable producers to select breeds with the most efficient growth patterns.

Growth characteristics of lambs of Egyptian breeds (Rahmani, Ossimi and Barki) and their crosses with Finnsheep have been extensively studied (e.g. Mousa, 1989; Mokhtar *et al.*, 1991; Elshennawy *et al.*, 1998 and El-Wakil, 2004). Corresponding information on Romanov crosses have yet to be investigated.

Romanov sheep was first imported to Egypt from France by the Ministry of Agriculture in 1985. A crossbreeding program involving this breed was implemented to improve the productivity of Rahmani sheep in Mahallet Mousa Experimental Station. Growth data on pure Romanov (R), 1/2Rahmani 1/2 Romanov (1/2 R) and 3/4Rahmani 1/4 Romanov (1/4R) lambs were collected and used in the present study.

The objective of the study was to analyze these data to obtain growth curve parameters and their derivatives for lambs as influenced by breed group and non genetic factors, namely, sex, season of birth, type of birth, dam age and number of weights.

MATERIAL AND METHODS

Data:

In this study data were collected during the years from 1985 to1998 from sheep flocks raised at Mahallet Mousa Experimental Farm (North Delta) belonging to the Egyptian Ministry of Agriculture situated in northern Delta. A total number of 1693 lambs [136 Romanov, 782 1/2R and 775 1/4R] were available for the present study. The data represent monthly weights on both male and female lambs starting at birth. Only data from lambs with 12 or more consecutive weights were included in the analysis. An accelerated lambing system of three matings per two years was practiced. For Romanov crossbred ewes, mating seasons were May, January and September, while Romanov ewes entered one mating season per year in September. Ewes and rams were first mated at about 18 months of age. Lambs were weaned at about two months of age. Animals were sheared twice a year, in March and September. Lambs were crept from the fifth week of age till weaning on a concentrate ration (83% corn, 15% soybean, 2% salts and vitamins). From weaning to yearling age, crossbred lambs were fed on concentrate feed mixture (35% corn, 30% undecorticated cotton seed cake, 25% wheat bran, 6% molasses, 3% limestone and 1% mineral salts) together with corn, berseem hay, wheat bran and soybean, in quantities proportional to lambs weights. Animals were allowed to drink twice or thrice a day.

Growth function parameters:

Among the nonlinear growth models, Brody's function (Brody, 1945) was used to fit individual data as its validity in fitting growth curves has been already demonstrated in Egyptian literature (Mousa, 1989; Mokhtar *et al.*, 1991 and Elshennawy *et al.*, 1998).

In Brody's function $Y_t = A\,(1 - Be^{-Kt})$, Y_t is the observed weight of lamb at age t in days, A is the asymptotic weight, B is the parameter related to early life weight changes in body weight and provided for a Y-intercept term, e is the base of natural logarithms (2.30259) and K is the parameter indicating general rate of maturing or growth rate relative to mature weight. As K values are function of growth rates relative to mature weight they should only be used as indicators to compare growth rates of individual animals whose A values are equal (McCurley *et al.*, 1984). Larger K values characterize earlier maturing animals. The coefficient of determination (R^2) was calculated for each animal as a goodness of fit criterion.

Different and similar mature weights combined with different and similar maturing rates create various patterns of growth. Examples of combinations of A and K which were chosen to show the between sex within breed variability in growth patterns are presented in Table 1. Animals with different A values showed different or similar k values, and those with similar A values presented different or similar K values. According to brown *et al.* 1972, only when two animals are growing to similar mature weights, can K be considered as a measure of differences in growth rate, otherwise, K measures differences in growth rate relative to mature size. Different patterns of growth are attained when two animals have similar mature weights but different K values or similar K values but different mature weights. Different mature weights and different K values may or may not represent different patterns of growth. A larger mature weight accompanied by a small K value is unlikely to present a growth pattern different than a small mature weight with a large K value (Brown *et al.*, 1972).

Derivatives of growth parameters:

Brody (1945) defined the instantaneous growth rate (IGR_t), as $dy_t/dt = Ky_t(Be^{-Kt}/1-Be^{-Kt})$. The IGR_t was calculated for each animal at 2 (IGR2), 6 (IGR6) and 12 (IGR12) months of age.

According to Brown *et al.* (1976), the expression $(A-Y_t)/Y_t$ represents the amount of maturity (in weight) remaining to be attained as a fraction of the maturity (in weight) already attained at any age t ($AMRA_t$). The $AMRA_t$ was calculated for each animal at 2 (AMRA2), 6 (AMRA6) and 12 (AMRA12) months of age.

Statistical analysis:

Data were analyzed, using a least squares fixed linear model by Harvey's Mixed Model (1990), to estimate the least squares means for the breed group effect, the non-genetic effects (sex, season of birth, year of birth, type of birth, age of the dam, number of observed weights) and the first order interaction effects among these factors for growth parameters and their derivatives (IGR_t and $AMRA_t$). Individual estimates were obtained using the nonlinear procedure (NLIN) of SAS packages (SAS,1988).

An average growth pattern for three lambs from the studied breed groups is presented in Figure 1.

Table 1. Combinations of mature weight (A) and rate of maturing (K) representing different growth patterns in Romanov, 1/2 Romanov and 1/4 Romanov males and females

	Sex			
	Males		Females	
Breed	A (kg)	K	A (kg)	K
Romanov	36.15	0.0015	31.12	0.0038
	36.37	0.0054	31.64	0.0051
	36.42	0.0035	64.15	0.0011
	57.66	0.0035	47.30	0.0011
	43.43	0.0027	36.58	0.0052
	43.82	0.0027	36.36	0.0052
	56.95	0.0057	36.38	0.0042
	34.91	0.0083	65.55	0.0016
1/2Romanov	30.06	0.0070	30.45	0.0040
	30.30	0.0035	30.29	0.0072
	53.81	0.0013	82.63	0.0009
	83.03	0.0013	55.58	0.0009
	30.68	0.0063	30.29	0.0070
	30.73	0.0068	30.29	0.0072
	89.16	0.0012	47.81	0.0029
	41.32	0.0054	34.57	0.0052
1/4Romanov	31.88	0.0071	30.33	0.0078
	31.88	0.0035	30.37	0.0033
	52.31	0.0012	49.05	0.0014
	87.82	0.0012	62.31	0.0014
	30.28	0.0068	30.08	0.0056
	30.57	0.0062	30.26	0.0056
	40.92	0.0037	41.31	0.0046
	88.54	0.0011	61.14	0.0014

The estimates of A, B and K were used to predict weights from 0 to 18 months of age. Weighs predicted, though affected by errors in the original measures and errors of estimation of A, B and K, represent weights similar to actual weights (Figure 1) with the effects of temporary environment and errors averaged out. The predicted weight-age pattern is suppose to be more useful than actual weights in describing the pattern of relationships among growth measurements (Brown *et al*, 1972).

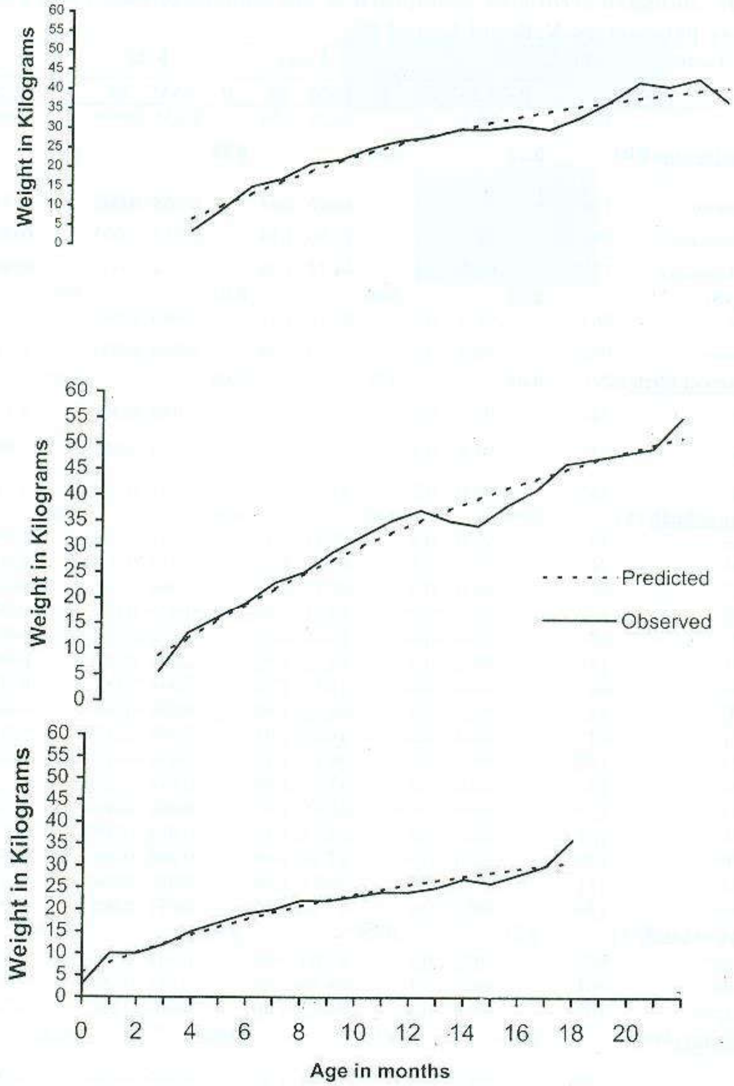

Figure 1. Brody's function fitted to observed weights for Romanov, 1/2 Romanov and 1/4 Romanov

RESULTS AND DISCUSSION

Growth parameters:

The mean least-squares estimates and their standard errors of growth curve parameters are shown in Table 2.

Table 2. The probability of type I error (P), least squares means (LSM) and their standard errors (SE) computed of the main factors affecting Brody growth curve parameters A, B and K, and R^2

Factor	No.	R^2			A (kg)			B (kg)			K		
		P	LSM	SE	P	LSM	SE	P	LSM	SE	P	LSM	SE
μ	1693		98.9	0.2		44.26	1.54		0.955	0.004		0.00419	0.00027
Breed group(BR)		0.22			0.85			0.72			0.94		
Romanov	136		99.2	0.3		44.16	2.44		0.958	0.007		0.00426	0.00042
1/2Romanov	782		98.7	0.1		43.90	1.14		0.952	0.003		0.00412	0.00020
1/4Romanov	775		98.8	0.1		44.72	1.04		0.954	0.003		0.00419	0.00018
Sex (S)		0.61			0.00			0.01			0.90		
Male	763		98.9	0.1		47.12	1.12		0.960	0.003		4.18	0.19
Female	930		98.9	0.2		41.39	1.29		0.950	0.004		4.21	0.22
Season of birth (SN)		0.49			0.56			0.00			0.09		
Feb.	744		98.9	0.1		43.63	1.04		0.950	0.003		4.47	0.18
June	533		98.8	0.2		45.33	1.58		0.950	0.005		3.89	0.27
Oct.	386		99.0	0.2		43.82	1.52		0.964	0.004		4.21	0.26
Year of birth (Y)		0.00			0.00			0.00			0.00		
1983	38		99.0	0.3		52.74	2.47		0.943	0.007		0.00309	0.00043
1984	74		99.1	0.2		42.17	1.82		0.939	0.005		0.00525	0.00031
1985	47		99.0	0.3		48.77	2.23		0.968	0.006		0.00334	0.00039
1986	137		98.4	0.2		40.61	1.48		0.975	0.004		0.00472	0.00026
1987	67		99.0	0.2		42.87	2.01		0.959	0.006		0.00392	0.00035
1988	141		99.2	0.2		40.83	1.48		0.932	0.004		0.00365	0.00026
1989	69		99.0	0.2		41.59	1.98		0.948	0.006		0.00371	0.00034
1990	85		98.9	0.2		46.58	1.70		0.930	0.005		0.00393	0.00029
1991	78		99.2	0.2		41.39	1.95		0.945	0.006		0.00446	0.00034
1992	184		99.3	0.2		48.12	1.39		0.934	0.004		0.00311	0.00024
1993	87		99.0	0.2		43.45	1.90		0.938	0.005		0.00406	0.00033
1994	151		96.9	0.2		41.55	1.37		0.983	0.004		0.00484	0.00024
1995	102		99.1	0.2		40.43	1.56		0.985	0.005		0.00503	0.00027
1996	148		99.0	0.2		42.39	1.40		0.966	0.004		0.00476	0.00024
1997	151		99.3	0.2		46.93	1.30		0.963	0.004		0.00434	0.00023
1998	134		99.2	0.2		47.72	1.46		0.971	0.004		0.00486	0.00025
Type of birth (T)		0.71			0.78			0.04			0.00		
Single	829		98.8	0.2		43.60	1.40		0.948	0.004		5.22	0.24
Twin	764		98.9	0.1		44.36	1.09		0.955	0.003		3.77	0.19
≥Triplet	100		99.0	0.2		44.82	1.66		0.962	0.005		3.59	0.29
Dam age (DA)		0.10			0.07			0.88			0.09		
1	284		98.7	0.2		46.06	1.36		0.955	0.004		0.00390	0.00024
2	683		98.9	0.1		43.96	1.06		0.955	0.003		0.00445	0.00018
3	500		98.7	0.2		41.82	1.38		0.957	0.004		0.00403	0.00024
4	226		99.4	0.3		45.19	2.21		0.952	0.006		0.00439	0.00038
No. of weights (NOW)		0.13			0.00			0.00			0.00		
12-15 WT	266		98.8	0.2		40.60	1.60		0.974	0.005		5.04	0.28
>15 WT	1427		99.1	0.1		47.92	0.86		0.936	0.002		3.34	0.15

R^2 was high significantly affected by SN*NOW and significantly affected by DA*SN. A was high significantly affected by BR*SN and significantly affected by BR*NOW, B high significantly affected by T*NOW and K significantly affected by BR*T.

The R^2 estimate was 98.9%, indicating that Brody's function is a statistically acceptable model for describing the growth curve of the studied sample of sheep.

This is in agreement with Elshennawy *et al.* (1998) in their study on crosses with Finnsheep.

Romanov and its crossbreds with Rahmani sheep had similar (P>0.05) growth parameters.

The effect of sex was highly significant (P<0.01) on A and B but not significant (P>0.05) on K. Males had higher estimates of weight at maturity and at the initial life stages.

Season of birth did not seem to affect A or K significantly (P>0.05). It had significant effect on B. Lambs born in autumn showed higher initial weight changes than those born in spring or summer.

Year of birth affected A, B and K significantly (P<0.0001). The A and B estimates showed initial drops but late improvement with progress of years of the experiment. The K values showed a trend of increase with years.

The effect of type of birth was not significant (P>0.05) on A, significant (P<0.05) on B and significant (P<0.01) on K. Born lambs as twin and triplet realized higher estimates of weight at maturity and at early life stages than that of lambs born as single.

Dam age had not significant (P>0.05) effect on the considered growth parameters.

The relative magnitudes of the components of variance for breed groups, sex, season of birth, year of birth, type of birth, age of the dam and number of observed weights are presented in Figure 2 for A, B and K. As expected, number of observed weights is the major source of variation in all growth parameters. Specifically, large contributions were noticed for sex in differences in A, for year of birth in the variation in B and for type of birth in the variation of K.

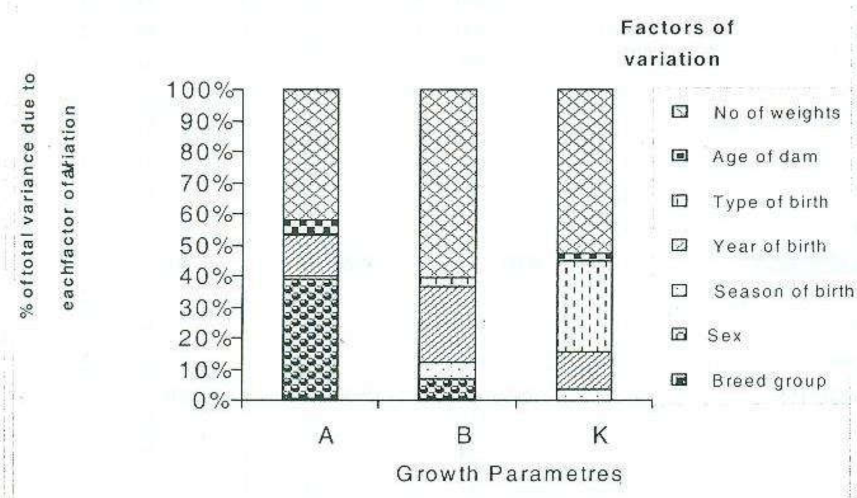

Figure 2. Partitioning of total variance into that attributable to breed group, sex, season of birth, year of birth, type of birth, age of the dam and number of observed weights

Instantaneous growth rate:

The mean least-squares estimates for the main factors affecting IGR_t are presented in Table 3.

Table 3. The probability of type I error (P), least squares means (LSM) and their standard errors (SE) computed of the main factors affecting the instantaneous growth rate (g) at 2 (IGR2), 6 (IGR6) and 12 (IGR12) months of age

Factor	No.	IGR2			IGR6			IGR12		
		P	LSM	SE	P	LSM	SE	P	LSM	SE
μ	1693		118	5		69	2		35	2
Breed group (BR)		0.10			0.02			0.60		
Romanov	136		118	6		69	3		35	3
1/2Romanov	782		114	3		68	1		35	1
1/4Romanov	775		122	3		72	1		36	1
Sex (S)		0.00			0.00			0.00		
Male	763		126	3		75	1		38	1
Female	930		110	3		64	1		33	1
Season of birth (SN)		0.08			0.02			0.06		
Feb.	744		120	3		68	1		33	1
June	533		112	4		69	2		37	2
Oct.	386		122	4		72	2		36	2
Year of birth (Y)		0.00			0.00			0.00		
1983	38		110	6		76	3		45	3
1984	74		134	5		68	2		29	2
1985	47		116	6		77	2		43	2
1986	137		127	4		71	2		32	2
1987	67		111	5		68	2		35	2
1988	141		98	4		61	2		33	2
1989	69		99	5		63	2		35	2
1990	85		104	4		61	2		33	2
1991	78		116	5		66	2		32	2
1992	184		100	3		67	1		39	2
1993	87		108	5		65	2		34	2
1994	151		129	3		71	1		33	2
1995	102		133	4		72	2		31	2
1996	148		128	4		71	2		33	2
1997	151		131	3		76	1		37	1
1998	134		142	4		80	2		38	2
Type of birth (T)		0.00			0.20			0.01		
Single	829		135	4		71	1		32	2
Twin	764		111	3		69	1		36	1
≥Triplet	100		108	4		69	2		38	2
Dam age (DA)		0.00			0.05			0.20		
1	284		116	3		71	1		37	2
2	683		124	3		71	1		35	1
3	500		112	3		67	1		34	2
4	226		120	6		70	2		35	2
No. of weights (NOW)		0.00			0.24			0.00		
12-15 WT	266		128	4		69	2		31	2
>15 WT	1427		108	2		71	1		40	1

IGR2 was high significantly affected by BR*T, IGR6 was high significantly affected by BR*SN and BR*NOW and significantly affected by SN*NOW and, IGR12 high significantly affected by BR*SN.

It seems that the increase in Romanov blood together with the decrease in Rahmani blood would adversely affect IGR_t. The results of IGR_t of Rahmani sheep (0% Romanov) reported by Elshennawy *et al.* (1993) were much higher than those obtained in the present work on 75% Rahmani + 25% Romanov which, in turn, were significantly higher than those recorded for 50% Rahmani + 50% Romanov. Decrease in adaptability to heat stress, exposure to solar radiation under extensive or semi extensive rearing systems may be responsible for the disadvantageous growth results of exotic breeds and crossbreds in the region (Hassan, 1991).

The instantaneous growth rate at all concerned ages was affected significantly ($P<0.01$) by sex. The higher estimates of instantaneous growth rate were observed for males than for females.

Season of birth had significant effect ($P<0.05$) on IGR6 and non significant on IGR2 and IGR12. Lambs born in autumn exhibited higher IGR2 and IGR6 than those born in spring or summer.

The influence of year of birth was significant ($P<0.01$) on instantaneous growth rate at all ages. The estimates of instantaneous growth rates did not show any specific trend through the years but they showed a pattern of increasing values with the last three years of the experiment.

The effect of type of birth was significant on IGR2 ($P<0.01$) and IGR12 ($P<0.05$). Single lambs gave higher estimates of IGR2 and IGR6 than that of twin and triplet lambs, while opposite results were observed with IGR12.

Dam age seemed to affect IGR2 ($P<0.01$) and IGR6 ($P<0.05$). It had non significant effect ($P>0.05$) on IGR12. IGR6 and IGR12 recorded higher ($P<0.05$) estimates for born lambs of young dams than for born lambs of old dams.

Amount of maturity remaining to be attained:

The mean least-squares estimates for the main factors affecting $AMRA_t$ are presented in Table 4.

The effect of breed group was non significant ($P>0.05$) on amount of maturity at all ages. The estimate of AMRA2 was slightly higher for Romanov than for 1/2Romanov and 1/4Romanov (Table 4). No significant differences ($P>0.05$) were observed for amount of maturity at all ages between males and females. Nevertheless, amount of maturity at 2 months of age was slightly higher for males than that for females.

The effect of season of birth was significant ($P<0.05$) on AMRA2 and non significant ($P>0.05$) on AMRA6 and AMRA12. Lambs born in summer showed a trend of higher amount of maturity at all studied stages than lambs born in spring and autumn.

Year of birth affected AMRA at all ages significantly ($P<0.01$). Fluctuant estimates of AMRA at all ages were observed through the years of the experiment.

The estimates of amount of maturity were significantly ($P<0.01$)affected by type of birth. The AMRA at all ages for single lambs was lower than that for twin and triplet lambs.

The effect of dam age was significant ($P<0.05$) on AMRA2 and non significant ($P>0.05$) on both AMRA6 and AMRA12.

Higher estimates of amount of maturity attained at 2,6 and 12 months of age were observed for progeny of young ewes than for those of old ewes.

Table 4. The probability of type I error (P), least squares means (LSM) and their standard errors (SE) computed of the main factors affecting the amount of maturity remaining to be attained (AMRA) at 2 (AMRA2), 6 (AMRA6) and 12 (AMRA12) months of age

Factor	No.	AMRA2			AMRA6			AMRA12		
		P	LSM	SE	P	LSM	SE	P	LSM	SE
μ	1693		3.82	0.23		1.22	0.09		0.47	0.02
Breed group (BR)		**0.68**			**0.67**			**0.49**		
Romanov	136		3.91	0.36		1.25	0.16		0.49	0.08
1/2Romanov	782		3.86	0.16		1.26	0.07		0.50	0.03
1/4Romanov	775		3.69	0.15		1.16	0.06		0.44	0.03
Sex (S)		**0.73**			**0.99**			**0.89**		
Male	763		3.86	0.17		1.23	0.07		0.48	0.04
Female	930		3.79	0.19		1.23	0.08		0.49	0.04
Season of birth (SN)		**0.04**			**0.12**			**0.15**		
Feb.	744		3.54	0.15		1.15	0.07		0.46	0.04
June	533		4.11	0.24		1.37	0.10		0.55	0.05
Oct.	386		3.82	0.23		1.17	0.10		0.44	0.05
Year of birth (Y)		**0.00**			**0.00**			**0.00**		
1983	38		4.27	0.37		1.50	0.16		0.63	0.08
1984	74		3.03	0.27		0.93	0.12		0.35	0.06
1985	47		4.37	0.33		1.41	0.15		0.56	0.08
1986	137		3.48	0.22		0.99	0.10		0.35	0.05
1987	67		4.08	0.30		1.30	0.13		0.50	0.07
1988	141		3.84	0.22		1.32	0.10		0.54	0.05
1989	69		4.21	0.30		1.36	0.13		0.54	0.07
1990	85		3.82	0.25		1.48	0.11		0.67	0.06
1991	78		3.60	0.29		1.13	0.13		0.44	0.07
1992	184		4.37	0.21		1.60	0.09		0.70	0.05
1993	87		3.80	0.28		1.28	0.13		0.52	0.07
1994	151		3.79	0.20		1.07	0.09		0.38	0.05
1995	102		3.53	0.23		0.97	0.10		0.33	0.05
1996	148		3.60	0.21		1.07	0.09		0.39	0.05
1997	151		3.81	0.19		1.19	0.09		0.45	0.04
1998	134		3.57	0.22		1.06	0.10		0.38	0.05
Type of birth (T)		**0.00**			**0.00**			**0.00**		
Single	829		3.04	0.21		0.93	0.09		0.34	0.05
Twin	764		4.01	0.16		1.33	0.07		0.53	0.04
≥Triplet	100		4.42	0.25		1.43	0.11		0.58	0.06
Dam age (DA)		**0.03**			**0.09**			**0.16**		
1	284		4.09	0.20		1.34	0.09		0.53	0.05
2	683		3.51	0.16		1.11	0.07		0.43	0.04
3	500		3.87	0.21		1.23	0.09		0.48	0.05
4	226		3.82	0.33		1.24	0.15		0.49	0.08
No. of weights (NOW)		**0.02**			**0.00**			**0.00**		
12-15 WT	266		3.56	0.24		1.02	0.11		0.37	0.05
>15 WT	1427		4.08	0.13		1.44	0.06		0.60	0.03

AMRA2 was high significantly affected by BR*SN and BR*NOW and significantly affected by S*NOW and AMRA6 and AMRA12 were high significantly affected by BR*SN.

CONCLUSION

With the increase of Romanov blood from 25% to 50% then to 100% almost no significant change has happened in mature weight, rate of maturity and instantaneous growth rates at 2,6 and 12 months of age. For these growth characteristics, more or less distinguished patterns were noticed between males and females and between single and non-single born lambs. With progress of years of experiment, some improvement in growth-related traits has been noticed.

ACKNOWLEDGEMENT

The authors are grateful to Dr. E.S.E. Galal for his criticism of the work.

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خصائص نمو الحملان من الرومانوف وهجن الرومانوف مع الرحمانى فى مصر

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تناولت هذه الدراسة خصائص النمو فى الأغنام من ناحية تأثرها بالمجموعة الوراثية (الرومانوف، ١/٢رحمانى-١/٢رومانوف، ٣/٤ رحمانى- ١/٤ رومانوف) والعوامل غير الوراثية (الجنس، وموسم الميلاد، وسنة الميلاد، ونوع الميلاد، وعمر الأم، وعدد الأوزان). وقد استخدمت الأوزان الشهرية لتقدير ثوابت منحنى النمو ومشتقاتها لكل حمل عند استخدام دالة برودى $Y_t = A\ (1 \qquad {}^{-Kt})$. وكانت متوسطات مجموع المربعات الدنيا لثوابت منحنى النمو هى A= ٤٤,٢٦ ، B =٠,٩٥٥ ، K = ٠,٠٠٤ ، وعند أعمار ٢، ٦، ١٢ شهرا على الترتيب. و كان معدل النمو اللحظى (بالجرام) ٣,٨٢، ١,٢٢، ٠,٤٧. وكانت كمية النضج المتبقية ١١٨، ٦٩، ٣٥ (%) وكان معامل التحديد ٩٨,٩ %. ولم تظهر فروق معنوية بين المجاميع الوراثية لجميع خصائص النمو المدروسة فيما عدا معدل النمو اللحظى عند عمر ٦ شهور. وكان تأثير الجنس معنويا ($p<0.01$) على *A, B* وعلى معدل النمو اللحظى عند جميع الأعمار. وقد أظهر موسم الميلاد تأثيرا معنويا على B($p<0.01$) وعلى معدل النمو اللحظى عند عمر ٦ شهور وعلى كمية النضج عند عمر شهرين ($p<0.05$). كان تأثير سنة الميلاد معنويا ($p<0.01$) على جميع خصائص النمو المدروسة، وتبين أن لنوع الميلاد تأثيرا معنويا على جميع ثوابت منحنى النمو ومشتقاتها فيما عدا A ومعدل النمو اللحظى عند عمر ٦ شهور. ولم يظهر لعمر الأم تأثير معنوي على أى من ثوابت النمو بينما كان تأثيره معنويا على معدل النمو اللحظى وكمية النضج عند عمر شهرين ($p<0.05$) وعلى معدل النمو اللحظى عند عمر ٦ شهور.