Effect of System of Management and Genotype on Reproductive Performance of Goats in Oman.

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Keywords: Goats - Management - Genotype - Reproductive - Performance.

Summary

This paper presents the effects of system of management and genotype on maternal performance of goats. Three goat breeds were used in a completely randomized (3x2) factorial design. Factors investigated were genotype or breed (local Dhofari : LD; Damascus "Shami": DS and Anglo-Nubian : AN) and management system (intensive: three matings / 2 years versus conventional : one mating/year). There was a significant (P<0.05) breed effect for birth weight, with D (S) goats being the heaviest and fastest in growth from birth to weaning and from birth to sexual maturity. D (S) showed higher twinning percent (80), litter size at birth (1.8), litter size at weaning (1.7) and litter weight at weaning, kg (28.4) than the other breeds. D (S) goats produced almost double the amount of milk per lactation (163 kg) compared to the other breeds. Higher economic returns (O.R./doe/year) were obtained with D (S) (28) than with LD (15.5) and AN (4.0). The system of management affected the maternal performance more than the goat genotype. Intensive system significantly (p < 0.05) improved prolificacy (2.1 versus 1.2); litter weight at birth, kg (7.0 versus 4.0) and litter weight at weaning, kg (27.0 versus 14.8). Intensive system of management substantially improved economic returns (O.R./doe/year) more than 300% (39.2 versus 9.0).

Résumé

Effet du système de gestion et de génotype sur la performance reproductive des chèvres en Oman

Cet article présente les effets du système de gestion et de génotype sur la performance maternelle des chèvres. Trois races de chèvre ont été utilisées dans un concept factoriel (3 x 2) complètement randomisé. Les facteurs étudiés étaient génotype ou race (Dhofari local : DL; Damas "Shami": DS et Anglo-Nubian : AN) et système de gestion (intensif : trois accouplements / 2 ans contre conventionnel : un accouplement/an). Il y a eu un effet significatif de race (P < 0,05) pour le poids à la naissance. Les chèvres D S étaient les plus pesantes et rapides en croissance de la naissance au sevrage et de la naissance à la maturité sexuelle. D S a montré le plus grand pourcentage des jumeaux (80), la prolificité à la naissance (1,8), la prolificité au sevrage (1,7) et le poids de la portée au servrage (28,4) kg par rapport aux autres races. Les chèvres D (S) ont produit presque le double de la quantité du lait par lactation (163 kg) comparées aux autres races. Le plus grand rendement économique (O.R./chèvre/an) a été obtenu avec DS (28) qu'avec DL (15,5) et AN (4,0). Le système de gestion a affecté la performance maternelle plus que le génotype de la chèvre. Le système intensif a amélioré de façon significative (p < 0,05) la prolificité (2,1 contre 1,2); le poids de la portée à la naissance, (7,0 contre 4,0 kg) et le poids de la portée au sevrage, (27,0 contre 14,8 kg). Le système intensif de gestion a considérablement amélioré les rendements économiques (O.R./chèvre/an) au plus de 300% (39,2 contre 9,0).

Introduction

Goat-raising plays an essential role in the agricultural economy of the Sultanate of Oman. All estimates agree that goats occupy the number one position among farm animals with respect to meat production in the country (2). The number of goats was estimated to be about 893,000 heads. Goats play a major role in meeting the demand for meat and milk (5). Goat meat is preferred by Omani and it commands a higher price than mutton. Goats in Oman are raised as dual purpose animals for both meat and milk, mainly under traditional extensive systems of management in the range and pastoral areas of the country (7). It was reported that local goats (Photo 1) were relatively poor producers compared to exotic breeds such as Shami (Photo 2) and Anglo-Nubian (Photo 3) (1). The latter breeds, were

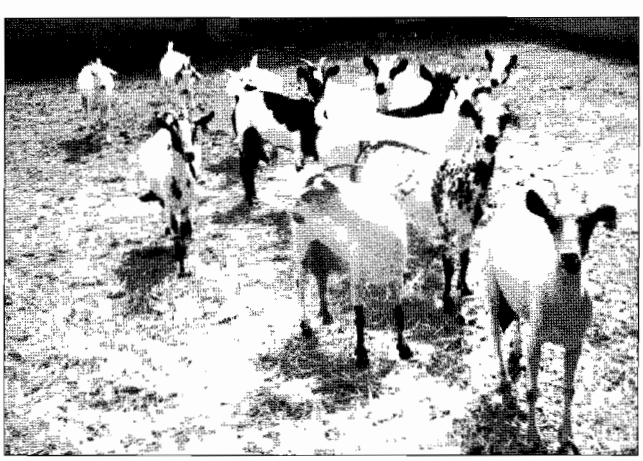

Photo 1 : Local Dhafari goats, 1998

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Photo 2 : Damasus "Shami" goats, 1998

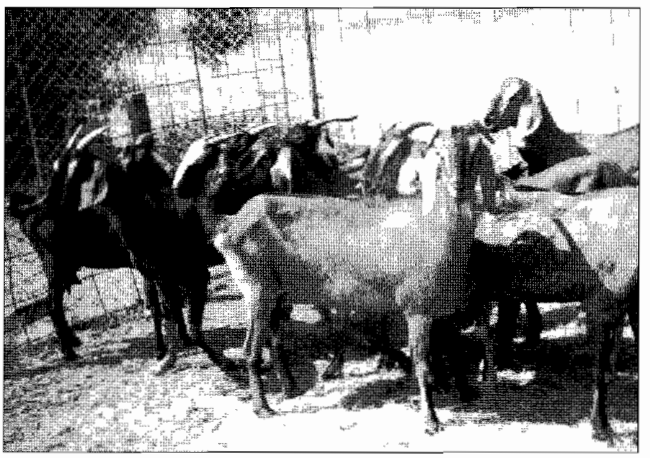

Photo 3 : Anglo-Nubian goats, 1998 Ramais

introduced in Oman mainly to improve productivity of local animals. Mahgoub and Lodge (7) reported that productivity of local Omani goats was rather poor under traditional management system, but tended to improve upon improvement of management and control of diseases. Maternal performance of Shami goats in Cyprus, in terms of litter size and litter weight at birth and weaning, respectively were reported as : 1.76; 6.9 kg and 1.5; 27.0 kg (4). Taylor (9) compared performance of local and Anglo-Nubian goats at Khabura in Northern Oman : the litter size for Anglo-Nubian and local goats was 2.0 and 1.26, respectively. Intensification of the production system of small ruminants can be achieved by two approaches : the first is to accelerate lambing/kidding by producing three lamb/kid crops every two years, the second approach is by introducing prolific breeds to be crossed with local animals. Both approaches have been evaluated in Egypt for improving sheep production and they have shown to be successful (6). With this in mind, this research was undertaken to evaluate reproductive performance of local (Dhofari) and exotic (Shami and Anglo-Nubian) breeds of goats under intensive or accelerated breeding (3 kids/two years) and conventional (kidding once/year) breeding systems, mainly to decide on the most suitable approach for improving goat production in the Sultanate.

Material and Methods

Animals ant their management

Sixty mature female goats from : local (Dhofari) LD; exotic Damascus (Shami) D (S) and Anglo-Nubian (AN) breeds were used in this study (20 animals/breed). Means and ranges of the liveweight of does in each genotype were 26 (20-30), 52 (38-69) and 35.2 (25-49) kg for LD, D (S) and AN, respectively. All does from the different breeds were ranging from the 2nd to 4th lactation season and were dry and ready for breeding when the experiment started by the 1st of December 1993. Animals in each genotype were randomly divided into two groups of 10 animals each (a total of 6 subgroups). Each sub-group was housed in a separate pen equipped with adequate water and feeding facilities. To one sub-group in each genotype a buck of the same genotype was put in the same pen for 2 months

Table 1
Chemical composition of the feeds consumed by the different breeds of goats (% DM-basis)

Nutrient	Feed	
	Rhodes grass	Commercial concentrate
Dry matter (DM)	20.0	90.0
Crude protein (CP)	9.0	14.2
Crude fiber (CF)	34.0	6.3
Ether extract (EE)	1.5	2.0
Ash	11.0	7.5
Nitrogen free extract (NFE)	44.5	70.0
% total digestible nutrients (TDN)	55.0	73.5

(until the end of January, 1994) i.e. one buck per 10 does. By the end of January, after mating, the bucks were taken out and each group of does in each genotype was housed together in the same pen until parturition. By the beginning of December 1994, bucks were introduced to the females again for 2 months until the end of January 1994 with the intention of having one kid per year (conventional system of management). In the other sub-group a buck of the same genotype was continuously left with does from December 1993 until December 1995 (two years). In this continuous breeding or intensive breeding system it was intended to have 3 kiddings per two years.

1. Diets and feeding methods

Does of all genotypes were fed a commercial concentrate diet (General Ruminant - 14% CP) manufactured by Oman Flour Mill and composed of barley, corn, oats, rice bran, soybean meal, limestone, sodium bicarbonate, salt, dicalcium phosphate, vitamins and trace mineral premix. The chemical composition of the concentrate is listed in Table 1. In addition to this concentrate green Rhodes grass *Chloris gayana* (composition shown in Table 1) and a trace - mineralized salt lick block consisting of : Ca, 1.3%; P, 0.23%; Mg, 0.3%; Mn, 200 mg/kg; Co, 124 mg/kg; L,190 mg/kg; Zn, 120 mg/kg; Fe, 1690 mg/kg; Se, 10 mg/kg; Cu, 400 mg/kg and vitamin D, 40000 IU/kg and NaCl were fed *ad libitum*. The average daily amounts of the feeds given to the does of the different genotypes at the different physiological conditions in the two systems were daily recorded and were listed in Table 2. Animals were

Table 2
Feeding schedule of the different breeds of goats in the two systems at different physiological conditions

	Type of management system					
	Intensive			Conventional		
	Goat breed*			Goat breed*		
Physiological condition and Duration	LD	D(S)	AN	LD	D(S)	AN
****Lactation :**						
Duration, days	225	225	225	150	150	150
Concentrate, kg/head/day	0.75	1.25	1.25	0.75	1.25	1.25
Green Rhodes grass	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*
***Dry period :**						
Duration, days	95	95	95	185	185	185
Concentrate, kg/head/day	-	-	-	-	-	-
Green Rhodes grass	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*
***Pregnancy (last trimester) :**						
Duration, days	45	45	45	30	30	30
Concentrate, kg/head/day	0.25	0.4	0.4	0.25	0.4	0.4
Green Rhodes grass	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*	*ad.lib*

* LD = Local Dhofari breed; D(S) = Damascus (Shami) breed; AN = Anglo-Nubian breed.

** All the year round during the different physiological conditions goats received in addition to the feeds, trace mineralized salt lick blocks and clean water daily.

Table 3
Effects of system of management and breed on maternal performance of goats

Trait	Breed			System of management		SE
	Local (Dhofari)	Exotic (Shami)	Exotic (Anglo-Nubian)	Intensive	Conventional	
Number of goats available for mating	20	20	20	30	30	-
Number of goats kidding	20	20	19	30	29	-
Fertility	100	100	95	100	96.7	-
No. of goats giving birth to singles	12	4	6	20	22	-
No. of goats giving birth to twins	8	16	13	10	7	-
Total number of kids born alive (males + females)	28	36	32	60 (40)	36 (36)	-
Twinning %	40	80	68	33	24	-
Prolificacy or litter size at birth	1.4	1.8	1.7	2.1^a	1.2^b	0.11
Birth weight*	3.0^a	3.75^b	3.3^a	3.3	3.35	0.075
Litter weight at birth (kg)	4.2	6.75	5.6	7.0^a	4.0^b	0.54
Litter size at weaning (LSW)	1.25	1.7	1.3	1.75	1.06	0.17NS
Weaning weight (kg)*	13.4	16.7	14.0	15.4	14.0	0.64NS
Litter weight at weaning (kg)	16.75	28.4	18.2	27.0^a	14.8^b	1.9
No. of dead kids from birth to weaning	2	2	7	6	5	-
% mortality from birth to weaning	7	5.5	22	10	14	-
No. of dead mother goats (does)	0.0	0.0	1	0.0	1	-
% mortality of does	0.0	0.0	5	0.0	3.3	-

* Birth and weaning weights were pooled weights for males and females.
N° between parentheses refer to the number of kids produced per one breeding cycle (note that there were 3 breeding cycles for intensive system or 1.5 breeding cycle/year and one breeding cycle/year for conventional system).

group fed. Clean water was freely and permanently available for all animals at all times from an automatic water bowl.

2. Experimental design

The design was a completely randomized 3 x 2 factorial. The factors were goat genotype (breed) and system of management. In each system of management there were 10 goats from each breed.

Measurements and laboratory analysis

1. Animal weights

Does were weighed before allocation to the management system (just before the start of the trial) and immediately after kidding. Kids were weighed at birth and biweekly until weaning at three months. From weaning until one-year old, kids were weighed monthly. Litter size and litter weight at birth and weaning were recorded, in addition to mortality rate. Twinning rate and fertility were also computed.

2. Milk production

Does were milked within 7 days after kidding and then weekly until drying. Six animals from each breed were hand milked once per week. Does were separated from their kids for 24 hrs before milking. Butter fat in milk was determined biweekly for each breed.

3. Chemical analysis

Sub samples of concentrate and Rhodes grass were

Table 4
Means with standard errors for different milk traits studied for the different breeds of goats

Trait	Breed			System of management	
	Local Dhofari	Shami	Anglo-Nubian	Intensive	Conventional
Number of lactating goat	6	6	6	9	9
Lactation yield (kg)	88.5±22.5	163±45.5	83±21	166.5±29	111±21
Daily milk yield (kg)	0.56±0.11	0.96±0.26	0.58±0.13	0.7±0.17	0.7±0.16
Lactation length (days)	158±35	170±20	143±37	237±30	158±31
% fat in milk	4.2±0.67	3.8±0.04	4.5±0.45	4.1±0.4	4.2±0.3
Efficiency of converting feed into milk (kg conc./kg milk)	1.34	1.3	2.1	1.7	1.7

Table 5
Yearling weight (kg), feed intake; growth; feed conversion efficiency (FC) for growth from weaning to one year-old and the nutrient requirements for growth of the different goat breeds

Trait	Breed			System of management		
	local Dhofari	Exotic (Shami)	Exotic Anglo-Nubian	Intensive	Conventional	SE
Birth weight*(kg)	3.0[a]	3.75[b]	3.3[a]	3.3	3.35	0.075
Weaning weight (kg)	13.4	16.7	14.0	15.4	14.0	0.64
Yearling weight (kg)	29.5[a]	43.8[b]	38.5[b]	38.0	37.0	0.95
Daily gain from birth to weaning (g/head)	115.5[a]	144.0[b]	119.0[a]	134.0	118.0	0.21
Daily gain from weaning to one year (g/head)	59.6[a]	100.4[b]	90.7[b]	84.0	85.0	8.6
Overall daily gain from birth to one year (g/head)	73.6[a]	111.0[b]	98.0[b]	95.0	92.0	6.2
Average BW from weaning to one year old (kg)	21.5	30.2	26.2	20.7	20.2	-
Average daily feed intake from weaning to one year old :						
Concentrate (g/head/day)	500	750	750	667.0	667.0	-
Green Rhodes grass (g/head/day)	2050	2665	1500	1035.0	1040.0	-
Average total DM-intake (con.+ Rhodes) g/head/day	860	1208	975	807.0	808.0	-
Con. to roughage ratio (DM-basis)	52:48	56:44	69:31	74:36	74:36	-
DM-intakes as % BW	4.0	4.0	3.7	3.9	4.0	
(FC) efficiency for growth from weaning to one year old (DM-basis)	14.4	12.0	10.7	9.6	9.5	-
Nutritive value of the consumed diets during growth (weaning to one year) :						
% CP	11.6	12.0	12.5	12.9	12.9	-
% CF	19.6	18.5	15.3	13.4	13.4	-
% TDN	65	65.5	67.8	68.8	68.7	-

* Pooled birth weights for both males and females.

taken every month for proximate analysis, according to AOAC (3).

4. Economic evaluation

Economic returns per year from each system and each breed were computed by only considering the sales of meat and milk products as the major output whereas only cost of feeding was considered as the major input, other costs were ignored. Prevailing costs of feeds, milk and live animals were used at the time of conducting the trial.

5. Statistical analysis

Data were statistically analyzed as 2 x 3 factorial completely random design, according to Steel and Torrie (8).

Results

Table 3 summarized the effects of system of management and goat genotype on the performance of goats. Goats of the different breeds and in both management systems showed a good fertility ranging from 95 to 100%. Goats in the intensive system were more prolific than in the conventional system and D (S) were the most prolific with a litter size of 1.8 followed by AN (1.7) and LD (1.4). Both D (S) and LD were more fertile than AN. Fertility was also relatively higher (100%) under intensive compared to the conventional one (96.7%). Exotic goats were more prolific than LD, D (S) being the most prolific with a litter size of 1.8 followed by AN (1.7) and then LD (1.4). Goats in the intensive system were more prolific than in the conventional one (2.1 versus 1.2). Both birth and litter weights were different among breeds as well as among systems of management.

Shami goats D (S) had the heaviest birth weight and differences among genotypes were significant ($P < 0.05$). However there was no system of management's effect on birth weight of kids. D (S) goats also had the heaviest litter weight both at birth and weaning but differences were not significant. There was a significant difference ($P < 0.05$) between systems of management for both litter weight at birth and at weaning. However, weaning weight was neither significantly affected by genotype nor by system of management. In general D (S) had the heaviest weaning weight than

Table 6
Economic appraisal of the effects of system of management and goat breed on anticipated farmers income (taking only feed costs)

Trait	Breed			System of management	
	Local	Shami	Anglo-Nubian	Intensive	Conventional
Milk produced/doe/year,kg	88.5	163.0	83.0	166.5	111.0
Meat produced/doe/year,kg	16.75	28.4	18.2	27	14.8
Feed required*/doe/year:					
Concentrate, kg	166	268	268	280	188
Green Rhodes grass, ton	1.2	2.25	1.4	1.4	1.8
Income from milk, O.R./year	26.60	48.9	24.9	49.95	33.3
Income from meat, O.R./doe/year	20.90	35.9	22.7	33.75	18.5
Total income (meat+milk), O.R./doe/year	47.5	84.8	47.6	83.7	51.8
Feed costs					
Gross revenue/doe/year, O.R.	32	56.3	43.5	44.5	42.8
	15.5	28.5	4.0	39.2	9.0

Assuming cost per kg of live animal to be 1.25 (O.R.); cost of 1 kg goats milk to be equivalent to 300 Baisa; cost of 1 kg conc. to be = 84 Baisa and cost of green Rhodes grass per ton to be 15 (O.R.)
* Amounts of feed per year were calculated according to Table 5.

the other breeds. Growth performance (Table 5) was significantly ($P < 0.05$) affected by breed/genotype with the D (S) having the highest growth rate (both at preweaning and post-weaning growth phases as well as for the over all growth rate from birth to one year-old), followed by the AN and LD. However there was no effect of system of management on growth performance of goats. D (S) (Table 3) had the highest twinning percentage (80%) followed by AN (68%) and lastly LD (40%). In general, animals raised under the intensive system showed a higher twinning percentage than those kept under the conventional one. Mortality rate for both kids and does was higher for AN than for the other breeds, but rather similar between the two systems of management.

Milk production, butter fat in milk, length of lactation and efficiency of converting feed into milk are presented in Table 4. D (S) had a higher daily milk production per day and per season with the longest lactation period compared to the other breeds. Milk production was very similar between LD and AN goats and so was the butter fat content of milk. However, D (S) had a lower butter content than the other breeds.

Both lactation yield and length of lactation were greatly affected by system of management. They were both higher for the intensive system than for the other one. D (S) was the most efficient breed for converting feed into milk and was relatively similar to LD. AN showed the lowest efficiency for converting feed into milk. However daily milk yield, butter fat content and efficiency for converting feed into milk were not affected by system of management. Feed intake, growth, feed conversion efficiency for growth and nutrient requirements for growth are shown in Table 5. D (S) goats grew faster than the other breeds, followed by AN and LD. Feed intake also followed the same pattern as growth pattern. However, when feed intake was expressed as % of body weight, it was more or less similar between the different genotypes of goats. AN goats showed the best feed conversion efficiency for growth, followed by D (S) and then LD. Both feed intake and feed conversion efficiency for growth were not affected by system of management and were very similar for the two systems. Nutrient requirements for growth (for energy as % TDN, protein and CF) were neither affected by breed nor by system of management. They were very similar for the different genotypes and ranged between 11.6 to 12.5% for CP and 65-68% TDN for energy (DM-basis). Both concentrate and Rhodes grass (Table 1) reflected good nutritive value and were adequate in meeting nutrient requirements for the different genotypes of goats in their different physiological conditions (growth, lactation and pregnancy). The feeding schedule of the different goat genotypes in the two systems of management is summarized in table 2. Both D (S) and AN goats were given equal daily amounts of concentrate (1.25 kg/head/day) during lactation because of their heavier body weight in comparison to LD. However, LD goats were given only 0.75 kg of concentrate/day. During early pregnancy (after drying) goats received no concentrates and were fed on green Rhodes grass also as (green chop), free choice. During the last trimester of pregnancy goats were daily fed about 1/3 of the amount of the concentrate fed during lactation in addition to *ad. lib* amounts of Rhodes grass (green chop). The economic returns from the different goat genotypes raised in the two systems (taking feeding cost only as the main input and sale of meat and milk as the major output) are shown on Table 6. Both genotype and system of management greatly affected economic returns. It was clear that D (S) produced more milk and meat than the other breeds and goats managed intensively produced also more meat and milk than those managed by the conventional system. D (S) consumed more feed than the other breeds and also goats in the intensive system consumed more feed than the goats in conventional system. Goats raised by the intensive system required more concentrates and less Rhodes grass than in the conventional system. Gross revenue from the D (S) goats was the highest followed by LD and lastly AN. D (S) had about 80% more returns than LD. However, the intensive system of management was more profitable than the conventional system and returns were increased by more than 300% when goats were managed intensively.

Discussion

In this experiment, D (S) goats tended to have a better reproductive performance compared to the other genotypes as shown by an excellent fertility, prolificacy, heavier birth weight of kids, fastest growth rate, post weaning and until one year old, heaviest litter weight at weaning and the highest twinning percent (80%). Reproductive performances of D (S) goats obtained in this study was similar to those of D (S) goats in Cyprus (4). This shows that D (S) goats adapted very well to the environmental conditions of the Sultanate. AN goats performed rather poor and that was mainly attributed to the high mortality rate among kids in the preweaning stage (22%). In general, both twinning percent and litter size at birth for AN was better than for local animals. Local and D (S) showed a low mortality rate of less than 8%. No deaths were reported for both breeds for the mother does, whereas one adult goat of the AN breed died. Mortality among kids was caused mainly by pneumonia & diarrhaea and occurred mainly in the first month after birth in all breeds. Performance of local goats obtained in this study was similar to performance reported by Taylor (9), while AN goats performed poorer.

System of management did not significantly affect birth or weaning weights. However, both litter weight at birth and at weaning were significantly ($P < 0.05$) improved by the intensive breeding system.

Shami goats produced much more milk (163 kg/season) than the other breeds and were more efficient for milk production. AN goats were less efficient for milk production than local animals, but tended to be more efficient in converting feed into gain (growth) than both D (S) and local goats.

Nutrient requirements for growth of the different breeds were very similar and were in agreement with the requirements reported by El Hag *et al.* (5) for Shami goats in this station.

In general, more returns were obtained from D (S) goats than from the other breeds and it was very interesting to note that local goats showed better profitability than AN goats. System of management had a greater impact on returns or profitability than goat breed. Returns from intensifying production were 300% more than in case of conventional management system, whereas D (S) goats had 80% more returns than local animals. For better and increased profitability it would be advisable to combine both genetic and intensive management approaches for improving goat production in the Sultanate.

The results obtained for the effects of genotype and accelerated or intensive breeding as tools for improving goat production were in full agreement to what is reported in the literature (6). However, intensive breeding is not as simple as it sounds because it requires a high standard of management with a sound health program, keen and alert husbandman, available feeds (concentrates, forages and trace mineral blocks) and proper housing. Such intensive management system for goat raising in the Sultanate should be practiced in dry lots with capable farmers who grow irrigated forages in their farms, but not in villages and pastoral areas where feeds are very scarce particularly during summer.

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